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The British Journal of Surgery

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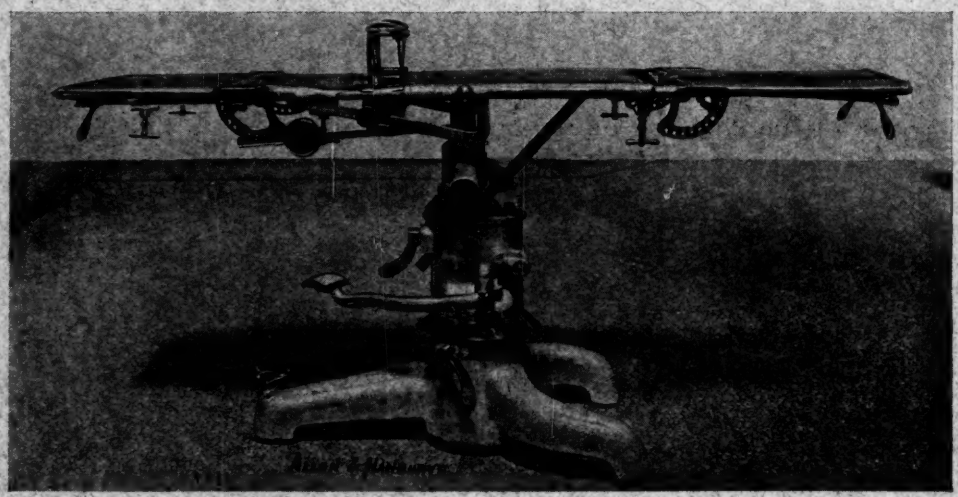

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CARCINOMA OF THE SUPRAPAPILLARY DUODENUM CAUSALLY ASSOCIATED WITH PRE-EXISTING SIMPLE ULCER.

REPORT OF A CASE, AND AN APPENDIX OF 30 COLLECTED CASES.

By GEOFFREY JEFFERSON, Victoria, B.C.

Carcinoma of the suprapapillary duodenum, whether associated with pre-existing simple ulcer or not, is a sufficiently rare disease to make all examples worthy of record.

Briefly, the story of the present case is this: A middle-aged man was operated upon for symptoms of food retention in the stomach; at operation a duodenal ulcer, to all appearances of the simple peptic variety, was discovered; a gastro-enterostomy was performed, and the patient made a good recovery. He remained well for some time, but three and a half years later he died, and at autopsy a duodenal carcinoma was found.

The present writer saw him only in the last stages of the disease; the history is largely the patient's own account of his illness.

History.—The patient was a male, age 55, a gentleman farmer of Alberta, who had owned woollen mills in England. He had never previously had an illness of importance. The first symptoms of the digestive disturbance appeared in the last few months of 1911. For the first time in his life he began to suffer from indigestion—pain in the epigastrium, followed by vomiting, the latter occurring only once or twice a week at first. As time went on the vomiting became more regular, till finally it was a daily happening. There was a remarkable periodicity about this vomiting, as it came on each day at the same time (about 5.15 p.m.—he said he could tell the time by the vomit). The amount vomited was small at first, but afterwards increased to large amounts, which were frothy, presumably from gastric stasis and fermentation.

As he was losing weight, he was advised by his doctor to have an operation. He came down to the coast for that purpose, and a posterior gastro-enterostomy was performed by a well-known surgeon of this city, with excellent results. The hospital record states that a duodenal ulcer was found, and the surgeon informs me that it was to all appearances an ordinary non-malignant lesion. After this short-circuiting operation, the patient put on flesh, returned to the prairie, and continued in excellent health for some two and a half years.

About a year ago he began to fail again and to lose flesh and strength, and about Christmas, 1914, a very troublesome diarrhœa set in, which continued without intermission until the day of his death. I saw the patient, who was an old friend, for the first time in February, 1915, when he had returned to the coast with the object of regaining strength. He was evidently in the last stages of malignant disease, being merely skin and bone. He had not vomited once since his operation more than three years ago. He had lost 24 lb. in eight weeks, and for this he blamed the diarrhœa.

On Examination.—The abdomen presented a marked contrast to the rest of his body, which was emaciated in the extreme. The abdomen was generally distended, apparently by dilated coils of intestine. There was visible peristalsis in the sub-umbilical region. There was no palpable tumour, and no ascites. Per

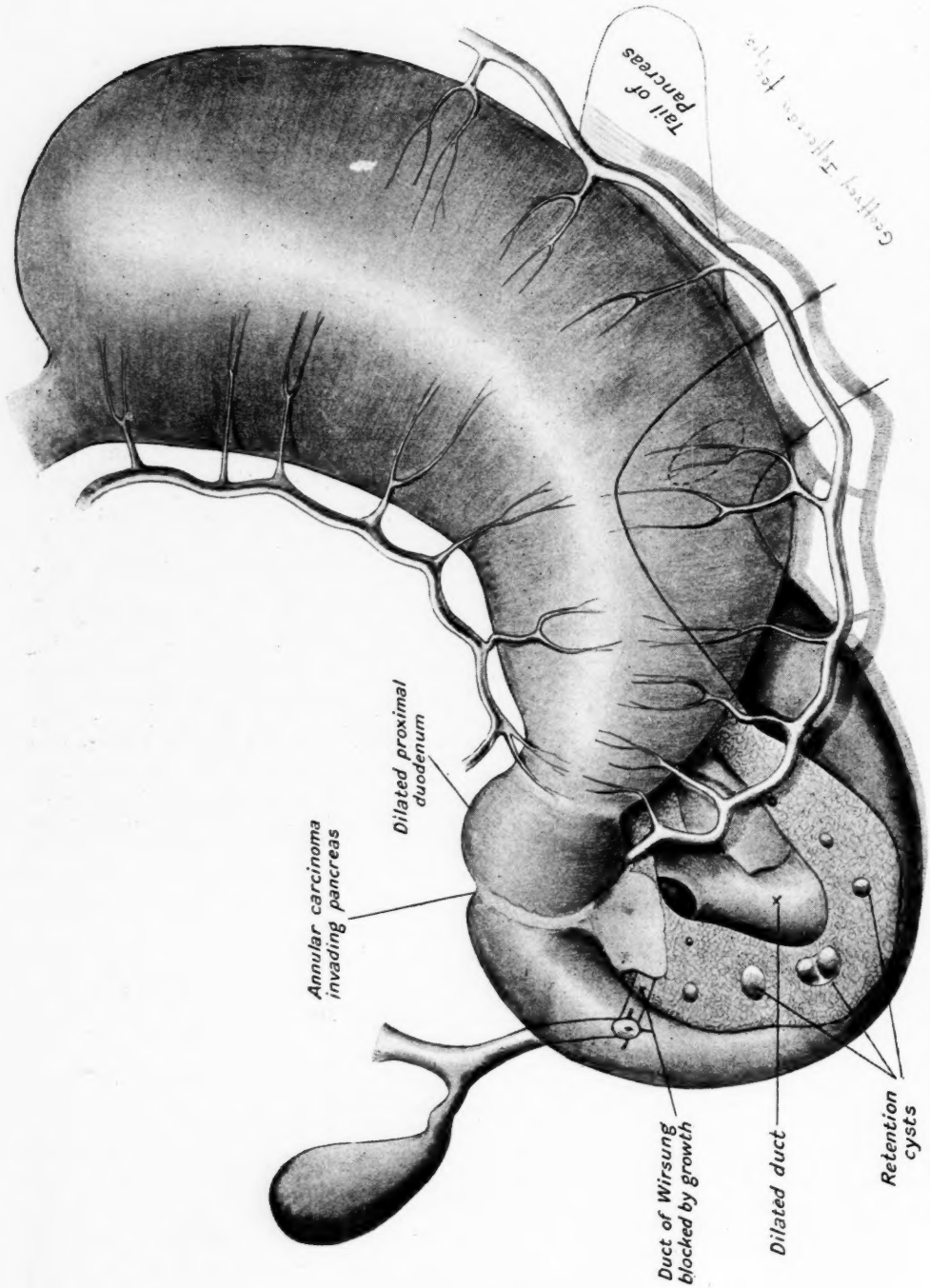

FIG. 132.—Reconstruction drawing of author's case of carcinoma of the duodenum. The head of the pancreas is invaded, and the duct of Wirsung obstructed, leading to the formation of retention cysts.

rectum, nothing abnormal could be felt. The urine was as follows: sp. gr. 1018, no albumin, no sugar, no diacetic acid. The fæces were very abundant, pale, fatty, and offensive—typical pancreatic stools, and not the diarrhœa of an enteritis.

The patient had several sharp attacks of abdominal pain, but there was no indication for surgical intervention. He finally died of exhaustion, April 5, 1915.

Post-mortem Examination.—An examination of the abdomen was made three days later; the body in the meantime had been injected with formalin. The anatomical diagnosis was as follows: carcinoma of the suprapapillary duodenum, extending into the head of the pancreas; obstruction of the duct of Wirsung, with retention cysts of the pancreas; metastatic carcinoma in two or three glands at the liver hilum; chronic perforative peritonitis of both sacs.

Duodenum.—About 2·5 cm. from the sphincter pylori is an annular malignant growth, completely encircling and obstructing the gut. This neoplasm has a smooth, whitish, non-ulcerated surface, and forms an impassable stricture, through which not even a fine probe can be passed. The growth has extended from the duodenum into the upper aspect of the head of the pancreas (*Fig.* 132). There is no sign of any preceding simple ulcer, so that if this carcinoma has been implanted upon an ulcer it has destroyed all signs of such an origin. The growth stops short of the bile papilla by about 2 to 3 cm. The common bile-duct can be readily catheterized in a retrograde manner. No probe can be passed into the ductus pancreaticus (Wirsungii). The papilla minor of Santorini cannot be discovered, and probably has been destroyed by the growth.* The duodenum proximal to the growth is widely dilated. No perforation of the gut to account for the peritonitis could be found at autopsy; but it may easily have been missed, as the duodenum was torn in process of removal, owing to the bewildering peritoneal adhesions which gummed the coils of intestine together. Microscopically, the growth was a columnar-celled carcinoma (*Fig.* 133).

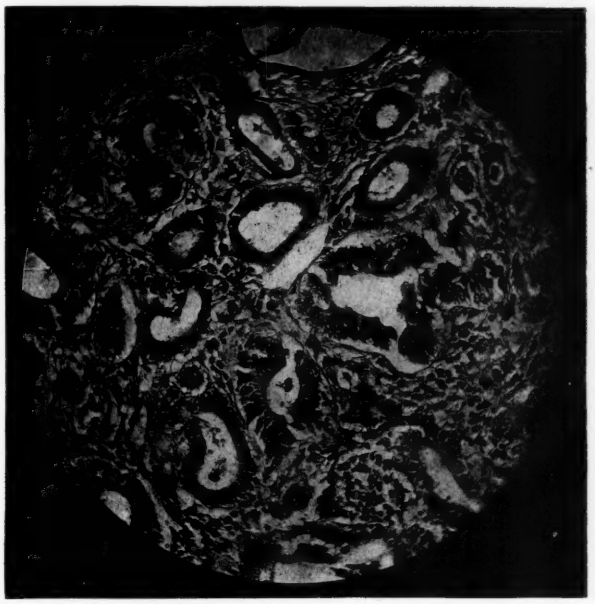

Fig. 133.—Photomicrograph of columnar-celled carcinoma of the duodenum. (*High power.*)

Pancreas.—The pancreas as a whole is slightly enlarged. Its surface is smooth, and it has lost its coarsely lobulated appearance. This is due to the dilatation of the ducts, which are markedly enlarged throughout. The upper surface of the head of the pancreas, where it is in contact with the suprapapillary duodenum, has been invaded by an extension of the carcinoma from the duodenum (see *Fig.* 132). The depth of this invasion is equal to about 3 cm. On section, the pancreatic-duct

* Of four cases of malignant obstruction of the Wirsungian duct mentioned by Crohn,[10] in only one was the accessory duct found at all; it was much dilated, and ended blindly in the head of the pancreas. In the other three cases it was either congenitally absent or previously atrophied (loc. cit., p. 853).

system is seen to be dilated to form a number of intercommunicating cystic cavities (*Figs.* 134, 135); the lining membrane of the cysts is smooth and shining. The cysts stop on the pancreatic side of the carcinoma, which has evidently destroyed the last portion of the main duct so completely that no secretion could escape into the duodenum. The pancreatic tissue proper has been reduced to a minimum by back-pressure. A probe passed into the ampulla is stopped by the growth. At the tail of the pancreas is a small necrotic area.

Stomach.—The stomach is healthy in every respect. The stoma of the gastro-enterostomy made three and a half years ago is patent and quite normal. The pylorus is normal, and is separated from the growth by some 2·5 cm. of healthy, though dilated, duodenum. The dilatation of the duodenum was not marked enough to give rise to an hour-glass appearance, such as some writers have described.

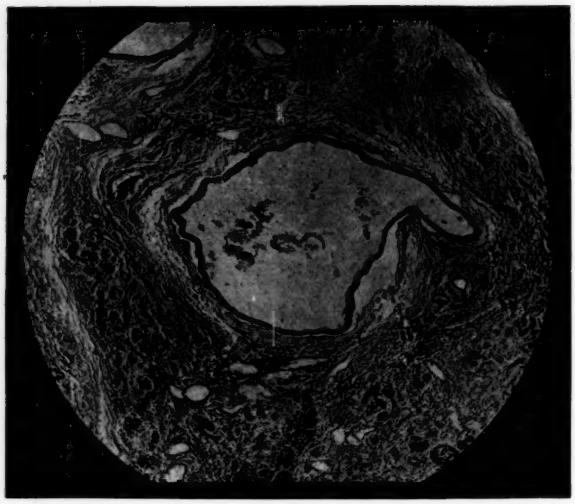

FIG. 134.—Section of the pancreas through a distended small duct. Note the extreme fibrosis of the organ. The zymogenous tissue is very much reduced.

Peritoneum.—The peritonitis was of some standing, both sacs being involved. The matting together of the coils of intestine must have led to a certain amount of physiological disability (i.e., obstruction); hence the visible peristalsis observed clinically.

Note upon the Clinical Aspects of the Case.—The most interesting point is the apparent grafting of the carcinoma on a simple ulcer base. The fact that no sign of an old ulcer was to be found at autopsy is not surprising, as the carcinoma had run its full course, and one would have expected it to have destroyed all trace of its origin. It may be argued that the case was one of carcinoma from the outset, and that at the operation it was seen in its early stages before its malignancy could be recognized. Although this is very plausible, I do not think that such was the case, and for this reason: He was operated upon for gastric stasis only a few months after he had begun to suffer from indigestion for the first time. Now, if it was a duodenal cancer from the outset, it is remarkable that it should have been large enough to have produced food retention, and yet be mistaken at operation by an experienced surgeon for a simple ulcer. Equally it is peculiar that a duodenal ulcer of about four months' standing should cause stenosis; for in the early stages gastric hypermotility and rapid emptying is the rule, as radiographers have taught us. The probabilities are, it seems to me, that he had had a latent duodenal ulcer for some time, and that it was not until it began to cause duodenal stasis that he suffered any distress and began to vomit. The gastro-enterostomy completely relieved him for two and a half years, when malignancy supervened and destroyed his life. The duration of life in duodenal carcinoma is said to be very short—three months

to one year, according to Pic,[1] whilst the Fenwicks give seven months as the average.[2]

This case also exemplifies the difficulty that can be introduced into diagnosis by a previous gastro-enterostomy. The classical signs of supra-papillary duodenal cancer, which are those of pyloric obstruction, and closely resemble those of carcinoma of the pars pylorica ventriculi, were all lacking. There was no vomiting at all. The abdomen was distended, there was visible hypogastric peristalsis, and yet there were frequent bulky stools—altogether rather an anomalous picture. There can be little doubt that the patient died finally of the chronic peritonitis and the deprivation of the pancreatic juices. It is noteworthy that the onset of the diarrhœa marked the beginning of a very rapid decline and loss of flesh. Einhorn,[3] in a recent paper, has

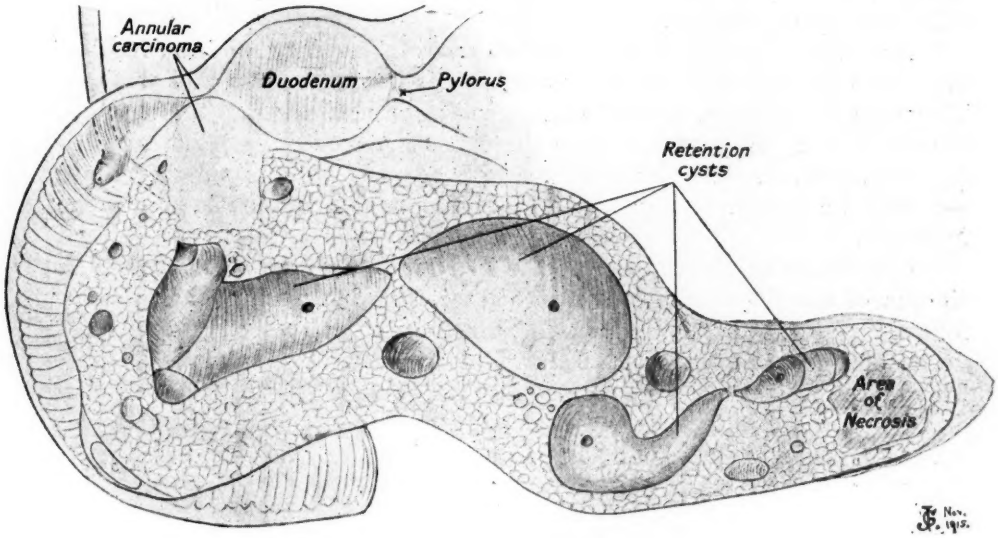

FIG. 135.—Schema of the dilated pancreatic-duct system. It is difficult to convey a correct impression, as the duct bent at sharp angles backwards and forwards.

drawn attention to pancreatic diarrhœa—a copious, fatty, pale, offensive stool, containing easily recognizable portions of undigested food—as a sign of the complete absence from the intestine of the pancreatic ferments. He has proved their absence in his own cases by means of his duodenal bucket. This case typifies his contention to a nicety, for at post-mortem the pancreatic duct was found to be completely occluded. In the present case, the bile-duct was not obstructed; but as Moynihan[4] has pointed out, the typical fæcal colouring is not due to the bile alone, but to an interaction between that secretion and the pancreatic juice; Lauder Brunton[5] has suggested that the pallor is also due to the large amount of undigested fat present. Involvement of the pancreatic duct with escape of the bile-duct has been noted before (Vincent Griffon[6]), but is a commoner result of primary pancreatic than of duodenal carcinoma.

It is very interesting to note that there was no glycosuria at any time in this case, although the pancreatic duct was completely obstructed. This is in complete accord with animal experiments where the duct has been tied (Tiberti,[7] Waterman,[8] and Zunz and Mayer[11]); atrophy of the zymogenous pancreatic tissue gradually follows this procedure, but the islets of Langerhans are unaffected for much longer; there is no glycosuria until they are destroyed by pressure of the fibrosis which gradually obliterates the whole gland. That this may not occur for a very long time has been shown by Mary Kirkbride.[12] She examined microscopically a portion of the pancreas which had been isolated and had had its ducts ligatured fifteen months previously; there was no trace of acinar cells, but the islets of Langerhans persisted and appeared to be actively functioning. The individuality of the islet cells has been set upon a firm basis by the microchemical investigations of Lane;[52] and Homans[9] has definitely produced experimental diabetes by exhaustion of islet cells through over-stimulation.

Bard and Pic[13] have recorded two cases of carcinoma of the head of the pancreas obstructing the ductus pancreaticus in which glycosuria was present. They suggest that this is due to an ascending interacinar pancreatitis destroying the islets. In my own case there has been extreme pancreatic fibrosis (see *Fig.* 134), and the glandular tissue is reduced to a minimum; but islets can still be found, though they are difficult to distinguish, and some are hydropic.

Frequency of Carcinoma of the Duodenum.—It is well known that carcinoma of the duodenum is a rare disease. This is amply illustrated by the following figures (*Table I*). It will be seen that duodenal cancer causes the death of but 1 in every 2500 hospital in-patients who come to autopsy. This gives an idea of its frequency, but for obvious reasons is far from representing its absolute incidence. Many surgeons hold that duodenal carcinoma is far commoner than is generally believed. This may be true, but it is certain that very few cases have been actually published.

Table I.—General Incidence of Carcinoma of the Duodenum.

Author	Source of Cases	Total Autopsies	Duodenal Cancer
Maydl[14]	Wiener allgem. Krankenhaus, 1870–1881	20,480	2
Nothnagel[15]	Ibid., 1881–1893	21,358	5
Perry and Shaw[16] ..	Guy's Hospital, 1826–1892	17,652	4
W. S. Fenwick[2] ..	London Hospital	19,518	18
McGlinn[18]	Philadelphia General Hospital	9,000	1
M. Müller[19]	Berne, 1886–1891	5,621	6
Fr. Müller[20]	Basle, 1874–1904	11,314	6
Rüpp[20]	Zurich	4,258	1
	Total ..	109,201	43

This table gives a percentage incidence of 0·04 for duodenal cancer in general.

Carcinoma is by no means common in any part of the intestine from the pyloric ring to the ileocæcal valve, whilst it is relatively exceedingly common immediately beyond the small-intestine confines at the places named. Thus, of 4177 intestinal carcinomata which I have collected, only 130 were in the small intestine (3·1 per cent).* That is to say, 96·9 per cent of intestinal carcinomata are situated in the large intestine and rectum. The rarity of carcinoma in the small intestine is puzzling, and has been variously explained by different authors, in accordance with their individual views on the cause of cancer in general. Some have believed that the liquid nature of the contents of the small intestine means a corresponding freedom of the mucosa from trauma.[47] Others hold that the abundance of pancreatic secretion makes it difficult for a neoplasm to develop (Beard[29]); there is probably but little in this theory, for Boldireff[28] has shown that a reflux of duodenal contents into the stomach occurs normally, and this evidently has no restraining power on gastric cancer. Those who uphold the parasitic theory, find in the rarity of duodenal cancer an argument in support of their contentions;[41] for bacteriologically, the duodenum is practically sterile,[49] and it is to be supposed that

Table II.—Comparative Incidence of Carcinoma in the Duodenum and Jejuno-ileum.

Author	Duodenal Cancer	Jejuno-ileal Cancer
Maydl	2	4
Nothnagel ..	5	6
M. Müller ..	6	3
Fr. Müller ..	6	2
Rüpp	1	1
Lubarsch ..	2	2
Barnard	5	10
Mayo	7	9
	34 (48 per cent)	37 (52 per cent)

it would be as free from the protozoon of cancer as from ordinary bacterial flora. In the present imperfect state of our knowledge of the origin of cancer it is idle to speculate further on this subject. It may be said, however, that when malignant disease of the small intestine does develop, it is usually engrafted upon a polyp, an adenoma, or a papilloma (Mayo). W. J. Mayo[30] figures a beautiful example of cancer of the duodenum arising from a juxta-pyloric papilloma. Mr. Mayo informs me that the patient had suffered from stomach trouble for twenty years.

It has been stated that rare though carcinoma of the small intestine is,

* The figures are from Leichtenstern[21] (33 in 794), Maydl[14] (6 in 100), Nothnagel[15] (11 in 243), Bryant[22] (6 in 110), M. Müller[19] (9 in 41), Fr. Müller[20] (8 in 123), Heimann[23] (20 in 1706), Lubarsch[24] (4 in 42), Rüpp[20] (2 in 35), Barnard[25] (15 in 481), Mayo[26] (16 in 502): total, 130 in 4177, or 3·1 per cent. Brill[27] has given the percentage as 2·5 on a smaller series, but there are mistakes in his calculations.

the site of election of such growths is the duodenum, and that as many as 75 per cent of small-intestine cancers develop there. This statement seems to be borne out by Köhler's[31] cases—9 duodenal cancers out of a total of 12 small-intestine growths. These cases are too few to draw conclusions from, and Brill[27] in his interesting paper discredits this percentage altogether. My own figures are entirely opposed to it also. I have collected 71 small-intestine cancers in which the situation of the growth is sufficiently accurately described: only 34 of these were in the duodenum, whilst 37 were in the jejuno-ileum; that is to say, 48 per cent of small-intestine carcinomata arise in the duodenum, instead of 75 per cent as has been erroneously stated (see *Table II*).

Considering the shortness of the duodenum, it is evident that, inch for inch, it is more liable to cancer than the rest of the small intestine; whilst the ileum seems to be more prone to this disease than the jejunum, for not more than half a dozen cases of the 37 noted above began in the latter.* W. J. Mayo reports two cases of carcinoma of the duodenojejunal flexure.[50] Whether these should be classed as jejunal or as duodenal is a matter of purely academic interest, depending on the point that one regards as the true termination of the duodenum (see Villemin[17]).

Distribution of Duodenal Cancer.—As to the distribution of carcinoma in the duodenum, there are various statistics according to the method of classification employed. There can be little doubt that the usual method of dividing the duodenum into three or four parts is not satisfactory for surgical pathology. All collected figures show that one-half or more of duodenal cancers are situated in the second part, owing to the complication of the duodenal wall in this region by the ampulla Vateri and the ducts of the liver and pancreas.

The Fenwicks' analysis of 51 cases is as follows: the first part was affected in 11, the second part in 29 (or 57 per cent), and the third part in 7. Geiser's more recent figures point to the rôle played by the ampulla Vateri in augmenting the incidence of cancer in the second part of the duodenum, for of 71 cases, no less than 51 (71·8 per cent) were peri-ampullary.[55] This does not necessarily indicate, as some seem to believe, that the mucosa covering the bile papilla is especially prone to malignant disease. Elsewhere the duodenal mucous membrane is comparatively simple, and cancer hardly commoner than in the rest of the small intestine. But at the papilla fresh factors are added. It is unfortunate that neoplasms commencing in the papillary region destroy all traces of their exact origin so rapidly that it is often difficult to determine at post-mortem whether the tumour is properly duodenal or ampullary. It is advisable that a strict line of distinction be drawn between the two, as the latter is not truly a duodenal cancer at all, but a growth in the biliary system. Ampullary cancer has been believed to be very uncommon; but Outerbridge[32] has recently collected 100 cases, and

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* Brill[27] states that the jejunum seems to be practically immune from cancer. However, of 52 recently collected cases in which the situation of the growth was known, the jejunum was involved as frequently as the ileum (Hinz[20]). This is confirmed by the work of Venot and Parcelier.[37]

several have been recorded since. These tumours have excited considerable interest in the literature, but will not further be referred to here.

Cancer is rather commoner in the suprapapillary duodenum than in the infrapapillary portion—11 to 9 (Geiser), 17 to 12 (Forgue and Chauvin[56]). It is possible that the slightly higher incidence of cancer in the former region is due to the frequency of chronic simple ulceration there. Of 496 duodenal ulcers collected by Flumerfelt and myself, 491 (99·2 per cent) were in the suprapapillary portion. Considering this comparative commonness of simple ulcer here, it is surprising that cancer is not more frequent, if there be a marked causal relationship between the two conditions. As will be seen below, the number of cases in which such a relationship can be suspected is very few (31 cases).

Duodenal Cancer arising in a Pre-existing Simple Ulcer (*Ulcero-cancer, Ulcus carcinomatosum*).—That cancer in all regions of the body frequently develops in a chronic simple ulcer is one of the best accepted facts of pathology. It has been generally conceded to be true of the surface of the body, of the lips and tongue, and of the cervix uteri; but considerable controversy exists at the present moment as to how true this axiom is of the gastro-intestinal tract. There are those who doubt whether cancer ever arises in tissue which has been hitherto perfectly healthy. They believe that a pre-existing ulcer or ulcerated simple neoplasm is a necessary antecedent of malignancy. On the other hand, there are a large number of workers who, whilst admitting the truth of these contentions in a limited number of cases, deny the wide prevalence of such a mode of origin. L. B. Wilson,[34] in a recent paper on the beginnings of carcinoma of the stomach, has expressed the situation very clearly. After pointing out that the total mucosal surface of the stomach, including the gland tubules, amounts to about 5000 sq. ft., he remarks that the hopelessness of searching for an early cancer in an area of such size would prevent anyone undertaking it: "It is possible that gastric cancers do originate in gastric mucosa which gives no grossly visible sign of irritation, and it is conceivable that some one may some time find such a cancer, though it will no doubt be accidental and on autopsy material. We have learned that the most likely place in which to find early gastric cancer is in the border of a chronic ulcer in a patient of cancer age whose history has caused the clinician to make a diagnosis of gastric ulcer and the surgeon to excise or resect a portion of the stomach containing the lesion."

One can no longer doubt that cancer of the stomach arises from simple ulceration in a great number of cases. The determination of the exact percentage of this happening is a matter of great difficulty. How often gastric and duodenal ulcers become malignant is, from its very nature, an almost insoluble problem. How often a cancer is preceded by a simple ulcer gives more promise of ultimate answer, though at the present time very different percentages are given by different writers.

However true of the stomach, the engrafting of cancer upon simple ulcer is by no means common in the duodenum. Rolleston[35] remarks that about 10 cases of such a happening are on record: these are 5 cases of Perry and Shaw,[16] and 5 collected by Nattan-Larrier.[36] To these cases I have been able

to add 20 more, making 30 in all.* This is a very small number compared with the large number of gastric cancers in which evidence of a previous simple ulcer has indisputably been found. A brief account of the cases which I have collected will be found in the appendix to this paper. It must be admitted that a certain number of the cases abstracted are doubtful, even very doubtful, examples of the sequence which their recorders believed them to illustrate.

Owing to the anatomical differences between the stomach and the duodenum, it is impossible that the gross pathological anatomy of cancer of the one should closely resemble cancer of the other. The large carcinomatous ulcer, for example, is impossible in a comparatively small tube like the duodenum. Houdard[38] believes that the rarity of ulcero-cancer of the duodenum, as compared with the stomach, is due to the rarity of chronic indurated ulcer in the former. This may well be true, for the callous ulcer is not so common in the duodenum as it is in the stomach; it has not the same amount of room to spread, nor the same thick submucosa to burrow into.

Why an ulcer which has remained simple over a long period of time should eventually become malignant is one of the secrets of cancer. It has been thought that Ribbert's theory of tissue-tension may explain the metaplasia, and that the islets of glandular tissue, which become cut off by scar tissue in the base of a chronic ulcer in the normal process of healing, are removed from the ordinary influences which control cell-division, and commence an unrestrained proliferation and infiltration. Tempting though this theory is, more recent investigation has shown that when an ulcer undergoes neoplastic change, the process begins deep in the margin of the ulcer, beneath its overhanging edge, and not in the middle of the base where the most typical of these 'post-natal rests' are to be found. And Bensley[39] has shown that the most active point of growth in the normal generation of gastric cells is the neck of the gland, and not the cells in its depths.

Evidently there are local factors, favourable or the reverse to the genesis of cancer, which are widely different in the walls of the various portions of the digestive tract. The gastric mucosa seems to be much more susceptible to cancer than the duodenal, for several cases are on record where a duodenal ulcer has extended through the pylorus and become malignant in its gastric portion only. Excellent examples of this happening are two cases of Sherren's in which gastro-enterostomies were performed for simple ulcers and the abdomens reopened a year later, to find that the duodenal parts of the ulcers had healed, whilst the intragastric portions had become malignant.[40] W. J. Mayo has recorded several similar cases,[48] which demonstrate in a very pertinent manner, better than any statistics or case figures, the markedly different susceptibilities of the stomach and of the small intestine to cancer.

Codman[53] believes that many so-called cancers of the pyloric end of the stomach begin on the duodenal side of the pylorus, and spread thence into the

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* A search was made through the *Index Medicus*, the *Index Catalogue of the Surgeon-General's Library*, Washington, D.C., the *Index of Current Medical Literature* (*Jour. Amer. Med. Assoc.*), and the *International Abstract of Surgery* (*Surg. Gyn. and Obst.*) for the past ten years (to 1914, when Brill's valuable paper appeared).

stomach, and the lymphatic flow certainly seems to be away from the duodenum and towards the stomach, as the work of Cuneo[54] well illustrates. An examination of 11 specimens of cancer of the pyloric end of the stomach showed the duodenum healthy in all but 4, though the duodenal surface of the sphincter was usually involved.[54] This small duodenal spread is probably due to permeation alone.

Before leaving this subject, mention must be made of a case of chronic duodenal ulcer which gave rise to a sarcomatous growth (Bland-Sutton[41]—see Appendix, *Case* 32). In this instance, the fibrous tissue in the ulcer base, instead of the duodenal mucosal cells, took on an uncontrolled proliferation. This must be a very rare occurrence indeed, but is interesting so far as it shows that the antecedents of sarcoma and of carcinoma are not necessarily widely different.

Duodenal Cancer arising in Pancreatic Rests or in Brunner's Glands.—The occurrence in some duodenal carcinomata of cells other than those of the usual cylindrical variety, has lead certain observers to believe that the neoplasm could not have started from the columnar cells of the duodenal walls. In looking around for other possible sites of origin, their attention has been attracted by the many islands of pancreatic tissue which are to be found beneath the mucosa of the suprapapillary part of the duodenum. They have further noted the presence of Brunner's glands, the acini of which dip down through the muscularis mucosæ, and which are fairly typical of the duodenum, in its proximal portion at least. Bland-Sutton[41] in a recent paper has scoffed at the idea that a duodenal cancer arises in accessory pancreatic tissue. So far as I am aware, there is but one fairly authentic case in the literature. This is Branham's case, examined by Professor Welch, and recorded by Branham in the *Maryland Medical Journal*, April, 1903.

Male, age 20. Growth at junction of pylorus and duodenum, measuring two inches by one. It occupied the anterior and inferior aspects of the pylorus, encroaching on the duodenum, and extending round about two-thirds of the circumference of the gut. The pylorus and adjacent part of the duodenum were excised, and an end-to-end anastomosis made. The first pathological report was that the case was a carcinoma of the pylorus. The specimen was re-examined by Prof. Welch later, who reports as follows: "*Examination of new growth in the walls of the pylorus:* The microscopical section submitted for examination shows the coats of the stomach. In the submucous coat is a granular mass presenting the structural features of the pancreas, with certain deviations from the normal type. There are spherical and oval acini lined or filled with cubical or cylindrical granular epithelial cells, their acini corresponding in shape and general appearance to those of the pancreas, and unlike any cancerous or adenomatous growth originating from the gastric tubules. These tubules are not in connection with this submucous growth. The granular mass consisting originally of the misplaced pancreatic tissue is the starting-point of a true tumour formation, characterized by irregular alveoli, usually lined, but sometimes filled, with epithelial cells of the same general type as those of the acini corresponding to the pancreatic tissue, but more polymorphous in character. These alveoli branch and anastomose and vary in size and shape. They are present not only in the submucous coat, but have grown downwards in the main muscular coat, which is extensively invaded, especially along the connective-tissue septa and between the two muscular coats. There is also some growth upwards invading the mucosa. Diagnosis: Malignant adenoma of the pylorus, originating from misplaced pancreatic tissue." Patient was well nine years later.

The only manner in which one could be quite certain that a given carcinoma had arisen in aberrant pancreatic tissue, would be the finding of an infiltrating neoplasm absolutely devoid of any connection with the cells of the mucous membrane. The growth should be entirely submucous. This condition is apparently fulfilled by Branham's case. The suprapapillary portion of the duodenum abounds in islands of pancreatic tissue, usually very small, it is true, but not infrequently of some size (Kremer[51] found 6 in 466 autopsies, and Mouchet 5 in 200—i.e., 1·6 per cent of 666 cases). These aberrant nodes are liable to acute inflammation; Carwardine and Short[42] have published an admirable example of such a happening. It cannot be denied that this tissue might be the starting-point of a neoplasm; but since all traces of its origin would usually be destroyed rapidly, undoubted examples will be rarely met with.

As for duodenal carcinoma arising from the cells of Brunner's glands, one must admit that this may well be so. But that such a growth would have cytological peculiarities does not necessarily follow. MacCarthy[43] has recently produced evidence that many of the cell differences of cancer in different organs are artificial, and that the cancer cell is practically always a perfect cell.

Prophylaxis and Treatment of Duodenal Cancer.—The number of cases in which duodenal cancer has supervened upon a simple ulcer basis being so small, the question arises whether the prophylactic removal of simple ulcer is sufficiently free from danger to justify the urging of this measure. The excision of simple ulcers of the stomach is based on sound surgical principles, and can be successfully carried out in the majority of cases. On the other hand, the removal of a duodenal ulcer is a more formidable undertaking, owing to the thinness of the bowel wall, its poor vascularity, and the fact that the suture line is exposed to a combination of powerful proteolytic ferments. Under these circumstances it will probably be sufficient if excision is reserved for the chronic, indurated, plaque-like ulcers, and for those which show a tendency to invade the stomach through the pyloric ring.

Supra- and infra-papillary carcinomata are best dealt with by resection and gastro-enterostomy, *secundum artem*. For the papillary variety, there can be no question but that they are best dealt with by circular resection of the duodenum, with transplantation of the biliary and pancreatic ducts (see Cotte,[44] Soulié,[45] and Coffey[46]).

SUMMARY.

1. Carcinoma of the duodenum is a rare disease. It is found in 0·04 per cent of hospital post-mortems (i.e., deaths from all causes).

2. Inch for inch the duodenum is more liable to cancer than the rest of the small intestine. Of 71 small-intestine carcinomata, 34 (48 per cent) were in the duodenum.

3. A causal relationship between simple ulcer and cancer is difficult to establish in the case of the duodenum. The writer, in recording a case of his own, has been able to find in the literature only 30 cases in which carcinoma seems to have developed upon ulcer. Several of these cases are very doubtful.

APPENDIX.

CARCINOMA OF THE DUODENUM ARISING ON A SIMPLE ULCER BASIS (*Ulcero-cancer*) :—

Case 1.—EWALD (*Berl. klin. Woch.*, 1886, xxxii, 527).—Female, age 67.

Dyspepsia for one year. Absence of free HCl in test breakfast.

Autopsy.—Duodenal ulcer, 2 cm. from the pylorus, which had become malignant. Margins of ulcer heaped-up and wall-like ; ulcer was circular, smooth, 1·8 cm. in diameter, and projected through the serosa as a nodular growth scarcely as big as a cherry, firmly adherent to the margin of the liver, into which the tumour had penetrated. Microscopically, there was firm connective tissue, with here and there strands of epithelial cells and accumulations of round cells. The condition was evidently a healed, round, duodenal ulcer, in the scar of which a carcinoma had commenced to develop.

Case 2.—EICHHORST (*Zeits. f. klin. Med.*, 1888, xiv, 519). Male, age 46.

Autopsy.—Round duodenal ulcer, with carcinomatous degeneration of the margins. Secondary growths in liver and spine, the latter having produced paraplegia.

Case 3.—SCHRÖTTER (*Aerztl. Bericht des k.k. allgem. Krankenhaus*, Wien (1886, pub. 1888).—Female, age 65.

In good health up to a year ago. She then began to suffer from catarrh of the stomach, icterus, great distension of the abdomen, œdema of extremities, rapid emaciation, etc., ending in death.

Autopsy.—A medullary carcinoma was found in the descending portion of the duodenum upon a round cicatricial ulcer base ; the head of the pancreas was also involved. There was metastasis in the lung.

Case 4.—PERRY and SHAW (*Guy's Hosp. Rep.*, 1893, l).—Male, age 48.

Admitted with jaundice, acute abdominal pain, vomiting, and typhoid symptoms.

Autopsy.—Anatomical diagnosis : Ulcer of the duodenum becoming malignant ; interstitial nephritis. The gall-bladder was quite obliterated, and the duodenum firmly adherent to its normal position, as was also the transverse colon. Its site was occupied by a firm tumour. On opening the common bile-duct, it was normal in its last three inches, but for half an inch beyond this point it was diminished by a yellowish-white deposit of cancer. Beyond this again the hepatic duct was dilated, and the branches throughout the liver similarly enlarged. Cancerous nodules were found in the liver. In the duodenum was an excavated ulcer about the size of half-a-crown, its base much depressed beneath the surface of the intestine, and its margin rounded. " It much resembled some of the chronic ulcers of the stomach." (There is no positive evidence that the duodenal ulcer was malignant. The case seems, rather, to be one of carcinoma of the common bile-duct.)

Case 5.—PERRY and SHAW (*Guy's Hosp. Rep.*, 1893, l).—Male, age 40.

Admitted under Dr. Habershon for enlargement of liver ; a few weeks' history of abdominal pain. Died eighteen days later.

Autopsy.—Ulcer of the duodenum becoming malignant. Liver full of secondaries, which were present also in the mediastinum. The pyloric end of the stomach and the duodenum were firmly adherent to the under surface of the liver. On opening these organs, a chronic ulcer was seen in the duodenum about an inch below the pylorus. It was round, the size of a threepenny piece, and sank deeply into the tissues. Its base was firmly adherent to the carcinomatous liver beneath.

Case 6.—PERRY and SHAW (*Guy's Hosp. Rep.*, 1893, l).—Male, age 45.

Ulcer of the pylorus and duodenum, becoming malignant.

Autopsy.—At the pylorus was an ulcer about the size of a shilling, partly in the duodenum and partly in the stomach. It had raised edges composed of cancerous material, but these were soft and of cheesy consistence, showing the cancer breaking up and degenerating. The whole thickness of the gastric and duodenal

wall was not affected, although the glands and omentum were extremely adherent, and there was much puckering of the tissues. Secondaries in the liver.

Case 7.—PERRY and SHAW (*Guy's Hosp. Rep.*, 1893, l).—Female, age 60.

No clinical history.

Autopsy.—Ulcer of the duodenum becoming malignant. First part of the duodenum was surrounded by a tough, firm, fibrous growth, which appeared for the most part outside the gut wall. There was an ulcer an inch in diameter on the posterior wall of the duodenum, with thickened edges and floor, the latter consisting of tough material in the portal fissure, apparently new growth, though the edge more resembled that of a simple chronic ulcer. Dr. Goodhart said, " It seemed to me to be a case of a new growth originating in the floor of a chronic ulcer and spreading thence to the surrounding parts."

Case 8.—GREENHOW'S case, published by SIDNEY COUPLAND (" Cancer of duodenum leading to obliteration of gall-bladder," etc., *Trans. Path. Soc. of London*, 1873, xxiv).—Male, age 72.

Jaundice of eleven weeks' duration. Died eighteen days after admission.

Autopsy.—Immediately behind the pylorus, and situated on the superior wall of the duodenum, was an ulcer of irregularly oval shape, half an inch in depth and occupying one-half of the circumference of the gut. The margins of the ulcer were thick and rounded, the base was indurated, fibrous, and cribriform. It was adherent to the liver by fibrous tissue of a semicartilaginous consistency. A very small secondary cancerous nodule was found in the liver. Microscopically, the growth was a cylindrical-celled epithelioma, or else a simple adenoma. Coupland thought that the duodenal lesion had been present long previous to this patient's fatal illness, and he based his diagnosis of malignancy mainly on the secondary node in the liver. (Perry and Shaw added this to their own four cases, under the heading " Ulcer of the duodenum becoming malignant.")

Case 9.—MACKENZIE, HECTOR W. G. (*St. Thomas's Hosp. Rep.* (1890, pub. 1892, xx).—E. K., female, age 47.

Died after illness lasting ten months: pain, gradually increasing jaundice, and enlargement of liver.

Autopsy.—An ulcer, the size of a shilling, surrounded the orifice of the common duct; edges adherent to the floor, but otherwise there was little evidence of cicatrization and no sign of growth about it. The liver, however, was very large and full of secondary deposits. Patient died of hæmorrhage (subdural and intestinal) due to jaundice. There is no mention of microscopical examination of the ulcer.

Case 10.—LETULLE, M. (" Cancer colloide du duodénum developpé sur un ulcére simple," *Bull. de la Soc. Anat. de Paris*, 1897, Oct., 721).—Male, age 55.

Treated for indigestion for some years; milk diet relieved the condition. Symptoms returned two years ago—vomiting, diarrhœa, emaciation. Died, apparently of gastric carcinoma.

Autopsy.—A cancerous mass was found in the suprapapillary duodenum. The pylorus was immensely distended, hardly recognizable. Between cancer and pyloric ring was a duodenal surface of about 2·5 cm.; in this region the mucosa presented the appearance of a typical cicatrix as formed by simple ulceration. Letulle believes that the cancer had arisen in the edge of this simple ulcer.

Case 11.—BUTZ, W. (" Ueber Duodenalkrebs und seine Komplikationen," *Inaug. Dissert.*, Konig. Univ. z. Greifswald, 1900).—Female, age 29, admitted to Frauenklinik at Greifswald for catarrhal jaundice.

Butz gives a very remarkable and detailed account of the course of this case (some twenty-five months). Exploratory cœliotomy discovered a hard mass at the biliary papilla, either ulcer or neoplasm: cholecystenterostomy; recovery. Readmitted a year later for gastric stasis. Gastro-enterostomy performed by Bier. Died six months later.

Autopsy.—Carcinomatous ulcer found in duodenum; cystic dilatation of

Wirsung's duct, atrophy of pancreas; carcinomatous pleurisy on left side, carcinomatous secondaries in right lung; many glands involved. Microscopically, an adenocarcinoma. (Butz discusses whether the carcinoma may possibly have arisen in a simple ulcer, owing to the long duration of the disease. The probabilities seem to be against this.)

Case 12.—Boxwell (*Lancet*, 1907, ii, 1687).—Male, age 60.

Suffered for some years from attacks of jaundice, sometimes with slight vomiting, but he never had much pain.

Autopsy.—Something like an ulcer occupying the ampulla of Vater, just at the entry of the common duct; carcinomatous nodules were scattered through the lungs, but there were no deposits in the liver.

Case 13.—Geiser (*Deuts. Zeit. f. Chir.*, 1907, lxxxvi, 1).—Female, age 64.

Short history of gastric disturbances, but an enormously dilated stomach, which reached to the pelvis.

Autopsy.—At a site 3·5 cm. distal from the pylorus was a severe stenosis, with an almost complete circular ulcer with broad indurated borders, and upon the ulcer base visible discoloured tumour masses resembling the pancreas. From the striking abundance of connective tissue present in the base of the neoplasm, it is evident that the cancer began from a simple ulcer. (Geiser then qualifies this by saying that the connective-tissue proliferation in the parts surrounding the common duct possibly had been caused by some gall-stones which were present.)

Case 14.—Chauffard (*Jour. Méd. Int.*, Paris, 1908, xii, 241).—Female, age 67.

Suffered from digestive disturbances for four years. Lost weight rapidly in last two years, vomiting and pain were almost incessant, and icterus was well-marked. Diagnosis: Cancer of the duodenum from simple ulcer of the stomach.

Autopsy.—An enormous vegetating cancer was situated at the second part of the duodenum, but suprapapillary.

Chauffard thus sums up the course of the case: (1) Precancerous stage; (2) Incipient stage of the cancer; (3) Stage of duodenal and biliary stenosis; (4) Period of ulceration, with re-establishment of biliary permeability.

Case 15.—Peck, C. H. (*Ann. of Surg.*, 1910, i, 952).

Operated on an acute perforated duodenal ulcer; no induration; good recovery. Second perforation a year later at same site.

Autopsy.—An extensive and deep duodenal ulcer, with a very small carcinoma, which must have developed in the interval since the first operation.

Case 16.—Mayo, W. J. (privately communicated).—Male, age 57.

Stomach trouble at intervals for ten years. Constant dull aching pain in epigastrium for past seven weeks. No vomit, no blood, lost only two pounds weight in six months.

Operation, June 12, 1909.—Carcinoma of the duodenum extending up to the pylorus. Anterior gastro-enterostomy for obstruction. "The carcinoma was so extensive that ulcer could not be demonstrated, but there was a ten-year ulcer history."

Case 17.—Mayo, W. J. (privately communicated).—Male, age 42.

Stomach trouble for two or three months ten years ago. Two years ago enteritis, then all right till four months ago. Night pain, relieved by vomiting.

Operation, August, 1915.—Contracting ulcer of duodenum involving pyloric end of stomach. Perforating, hard, indurated ulcer. Pathologist reported early cancer. Resection of three inches of pyloric end of stomach. Polya's operation. Seven days later, jejunostomy for stasis. Death one week later from pneumonia.

Case 18.—Moynihan, Sir Berkeley (*Duodenal Ulcer*, 2nd ed., 1912, p. 312).—Male, age 54.

Ten years' history of duodenal ulcer.

Autopsy.—A chronic ulcer of the duodenum was found. Most of the circumference was occupied by large nodular masses of carcinoma, which invaded the

pancreas also. The portion of the ulcer nearest the pylorus was thick and stiff, but no malignancy was discovered in it.

Case 19.—MOYNIHAN, SIR BERKELEY (*Duodenal Ulcer*, 2nd ed., 1912, p. 312).—Female, age 53.

In fair health till two months ago, then began to lose flesh, and to vomit. At operation, scar of old ulcer was found on anterior wall of duodenum; hard, craggy mass opposite to this on posterior wall at superior angle of duodenum. The pancreas was invaded. The autopsy provided confirmation. It was thought that the carcinoma started in an ulcer immediately opposite the healed scar in the first part.

Case 20.—BENEDICT, A. L. ("Relative hyperchlorhydria and pyloric obstruction due to cancer developing in duodenal ulcer," *Amer. Jour. Gastro-enterostomy*, Philadelphia, 1911, September).—An aged male.

Dyspepsia began about a year ago; induced vomiting frequently. No actual pain. Clinically, stomach was distended. Patient died suddenly.

Autopsy.—There was a broadly elliptical ulcer in the duodenum, 5 mm. by 7 mm. in minor and major diameters. From the base of this ulcer on the duodenal aspect of the pylorus a dense tumour had developed. The pyloric orifice was constricted, but admitted a large probe. Benedict remarks that it is probable that the duration of the lesion antedated by a good deal the six weeks covered by the history.

Case 21.—LECÈNE, P. (Described by Houdard (loc. cit., p. 141,), and by Hartmann, 23rd Congress of Surgery, Paris, 1910).—Male, age 59.

Twenty-one years ago treated for dyspepsia, by milk diet. Rapid improvement. Well till 1909, when he began to suffer again, and gastro-enterostomy was performed for gastric stasis. In the region of the second part of the duodenum was a ligneous induration on its postero-internal aspect. Remained well for nearly two years. Icterus then slowly developed, with pale stools. Palpable tumour under right rectus. At operation, a callous mass was found in the region of the first part of the duodenum; it involved the head of the pancreas. Gall-bladder greatly distended. Cholecystgastrostomy. Death.

Autopsy.—The existence of a cancerous degeneration of the ulcer, which had greatly narrowed the duodenum, was found.

Case 22.—DEAVER, J. B. (Recorded by P. G. SKILLERN, *International Clinics*, 1914, 24.s., iii, 205).—Male, age 55.

Had dyspepsia for twenty years.

Operation.—Carcinoma of the duodenum, pylorus, and pancreas, the last obstructing the common bile-duct. Cholecystduodenostomy.

Deaver remarks that the twenty years of dyspepsia suggests a primary ulcer of the pylorus or duodenum, with recent malignant degeneration and spread to the pancreas. "Primary carcinoma of the duodenum is rare, and in all probability usually develops from a preceding ulcer."

Case 23.—DEAVER, J. B. (*Arch. of Diagnosis*, 1908, July). Female, age 34.

Four months' history of vomiting after meals.

Operation.—On anterior wall of first portion of duodenum was a hard, infiltrated area, less than the size of the little finger nail. Removed. Posterior gastro-enterostomy performed. Many fine and dense adhesions were found between the stomach and liver, and between the stomach, duodenum, and gall-bladder.

Pathologist's Report.—Histological examination revealed evidence of chronic ulceration of the duodenal mucosa and inflammatory hyperplasia with cystic dilatation of the ducts. Below the submucosa, and intimately adherent to it, is a carcinoma of the adenomatous type, seemingly derived from the pancreas, of which tissue there are some areas in the section.

Dr. Deaver informs me that he believes that this neoplasm had begun in the chronic ulcer.

Cases 24–30.—MELCHIOR ("Ueber das chronische Duodenal-geschwur," *Deuts. med. Woch.*, 1910, No. 37).

Melchior wrote to a large number of surgeons asking a series of questions relative to duodenal ulcer in the practice of the surgeons addressed. Amongst the questions was one as to complications, perforations, ulcus carcinomatosum, etc. Five cases of ulcus carcinomatosum were recorded in the replies, and two of cancer (Garré) without mention of previous ulcer. It should be remarked that the cases are merely mentioned, without history or description. They are as follows :—

a. Von Angerer (Munich)	.. .. ..	1	ulcus carcinomatosum.
b. Bircher (Aaran)	.. ..	1	„ „
c. Von Haberer (Innsbruch)	.. .. ..	1	„ „
d. F. Holscher (Mühlheim a. Rhein)	.. ..	1	„ „
e. Rehn (Frankfurt a. M.)	.. .. ..	1	„ „
f. *g.* Garré (Bonn)	.. ..	2	carcinomata.

Melchior includes these last two cases with the others, and I have followed his example.

Case 31.—Jefferson, Geoffrey.—Case reported above.

Sarcoma of the Duodenum arising on a Simple Ulcer Basis.—The following case of sarcoma may be added to the above thirty-one cases of carcinoma possibly arising in a simple ulcer:—

Bland-Sutton, Sir John (*Lancet*, 1914, ii, 931).—Male, age 55.

Patient had well-marked symptoms of pyloric obstruction. At operation, a polypoid mass could be felt in the duodenum, and was easily pressed into the pyloric ring. There was a well-marked scar on the serous surface of the duodenum to within half an inch of the bile papilla. The parts were removed and a gastro-jejunostomy performed. The portion removed showed a fungating growth springing from the floor of the chronic ulcer. Microscopically, the neoplasm was a spindle-celled sarcoma. The patient died a month later. No autopsy.

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THE DANGERS OF INTESTINAL EXCLUSION.

By G. GREY TURNER, Newcastle-on-Tyne.

There is a good deal of evidence to show that many surgeons do not as yet fully appreciate the amount of secretion from the intestinal mucous membrane. Every now and again operations are performed in which no outlet is provided for this secretion, the oversight sometimes leading to fatal results. The matter must therefore always be borne in mind, and especially when performing palliative operations for irremovable malignant tumours. Professor Rutherford Morison drew my attention to this subject several years ago, and he has briefly referred to it in a paper on "Intestinal Obstruction," written in 1904,* and again quite recently in a paper entitled "Notes on Surgical Diseases of the Colon—A Warning,"† where he gives notes of two striking cases, with excellent illustrations. As 'exclusion operations' are frequently performed, the matter under consideration may be the cause of unsuccessful results more often than is supposed. Examinations after death are not often made in the case of patients who die at their own homes, especially when the disclosures of a recent operation apparently render them unnecessary. In text-books the subject is either insufficiently referred to or altogether ignored. These considerations have therefore encouraged me to report my experience.

Notwithstanding the splendid work of many physiologists, especially Pawlow, and of numerous radiologists, our knowledge of the functions of the intestine, particularly the large bowel, is very deficient. This is much to be regretted, especially when we consider for how many years surgeons, the world over, have been curing or making intestinal fistulæ in all parts of the bowel; while latterly resections of great magnitude have frequently been performed, thus providing unbounded opportunities for research. Sir Wm. Macewen pointed the way in his Huxley Lecture, "On the Functions of the Cæcum and Appendix,"‡ and recorded some valuable observations. Similarly, the Address on Surgery delivered by J. C. Bond before the Annual Meeting of the British Medical Association at Leicester, in 1905,§ was a great stimulus to work on living surgical physiology and pathology. Doubtless much other excellent work has been done, but the fact remains that a great mass of material has been wasted.

PHYSIOLOGICAL AND PATHOLOGICAL OBSERVATIONS.

There is a large amount of secretion from the mucous membrane of the bowel even under normal conditions, and when stimulated into greater

* *Edinburgh Medical Journal*, 1904, xvi, New Series, p. 54.
† *British Journal of Surgery*, 1915, Oct.
‡ *British Medical Journal*, 1904, Oct. 8.
§ *Ibid.*, 1905, July 29.

activity by irritation or infection, it may be enormous, as in the familiar example of colitis. In the small intestine, 'succus entericus' plays an important part in the ultimate digestion of food-stuffs, but in the large bowel mucus seems to be the most frequent and most copious secretion. Doubtless this mucus fills an important rôle; it is considered likely that it is the medium for the evacuation of certain salts, and it has been suggested that it interferes with the propagation of bacteria, as well as acting as a lubricant. In all parts of the intestine gases are also found in varying amounts, though little is known as to their origin, composition, or function.

A portion of bowel is said to be 'completely excluded,' when it is cut off at both ends from the rest of the intestinal canal, though retaining its normal vascular and nerve mechanisms. Under these circumstances we might expect

FIG. 136.—Large mucous cyst of the vermiform appendix.

that its secretion would be immediately greatly diminished, because the normal stimulus supplied by the moving contents is absent. We might also expect that the mucous membrane would soon become inactive, or atrophy, as occurs in the gall-bladder when there is a complete block of the cystic duct, or as in the case of the kidney when the ureter is completely and suddenly occluded. As a matter of fact, there is abundant clinical evidence to show that a large amount of secretion continues to be poured into the bowel. In all probability this is because the secretory nerves are still intact, so that the stimulus from the healthy normal intestine overflows into the excluded loop. As the secretion collects, the rate at which it is poured out probably lessens, while the accumulation in the bowel gradually exerts pressure on its wall and

interferes with the activity of the mucous membrane; so that sooner or later some atrophy probably does occur. Were it otherwise, the serious events which happen would not be as long delayed as they often are.

Should the contents of the excluded bowel be relatively sterile, it will fill with mucus, and will become gradually distended until either its wall gives way or a cyst forms. The latter is always liable to infection, and should this event occur, perforation into the peritoneal cavity will follow. If the contents are infected when the exclusion is carried out, then an acute process will begin much sooner, and will almost certainly infect the peritoneum.

There is much pathological evidence of what occurs under the circumstances. Perhaps the most familiar illustration is in connection with the vermiform appendix. Most surgeons are acquainted with cases in which this organ has become occluded at the cæcal end and in which no serious infection has been present to interfere with the secretion of mucus, which has continued until a cyst has been produced. Not infrequently such a cyst may attain the size of a thumb. It may be much larger; I have a specimen the size and shape of a lemon (*Fig.* 136), and I know of one as big as a child's head. Another good illustration is furnished by cases of pelvic abscess about to point into the rectum, a discharge of mucus per anum then being a characteristic feature, due to the very active secretion resulting from the greatly increased vascularity of the bowel wall. Similarly, when colotomy has been performed, followed by sacral excision of the rectum, the amount of mucus discharged from the intestine below the artificial anus may be a great annoyance. The enormous quantity of mucus which may be passed in cases of colitis is also a familiar example of the secretory power of the large bowel.

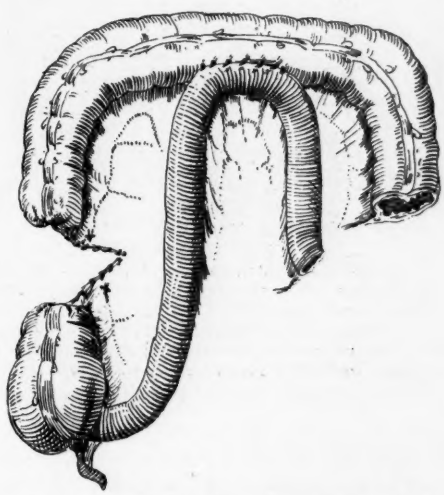

FIG. 137.—Illustrating the conditions in the first case. A growth of the ascending colon has been removed, and both ends of the bowel have been closed, a lateral anastomosis being made between the ileum and transverse colon. The cæcum became distended with mucus, and burst, leading to the death of the patient.

ILLUSTRATIVE CASES.

The first case which came under my observation occurred some thirteen years ago, as follows:—

A malignant growth of the ascending colon was excised, both ends of the bowel being closed and a lateral anastomosis made between the lower ileum and the transverse colon (*Fig.* 137). The ileocæcal valve proved competent, and the cæcum burst; this gave rise to a localized abscess, which in turn led to perforation of the external iliac artery and the death of the patient seven weeks after the operation.

From that time I have occasionally noticed reports of cases in the journals, and I have heard of others that have not been recorded, but no example has come under my own observation until the following case occurred.

The patient (Reg. No. 6196) was a man, age 40, who came under my care in November, 1913, complaining of a large, hard, tender lump in the right iliac fossa. He stated that for some few months he had been troubled with intestinal symptoms. A month previously he was seen by a surgeon, who made a diagnosis of malignant disease of the cæcum. During the few days preceding his admission to the wards with which I am associated, his condition had become much worse, with considerable pain and vomiting, while the lump had increased in size and become tender. From the history, I had no difficulty in concluding that the patient was suffering from a malignant growth of the cæcum associated with abscess, a condition which is fairly well recognized, and of which I have recorded examples.*

There was no evidence of dissemination of the growth; but before considering the possibility of its removal, it was necessary to deal with the inflammatory complication. An incision was therefore made directly over the mass in the iliac fossa. As soon as the peritoneum was incised, a little foul-smelling pus escaped, together with a small amount of fæcal material and mucus. The growth was infiltrating the abdominal wall; it was very hard, and clearly malignant. Some small pieces were removed for microscopic examination, and drainage was provided.

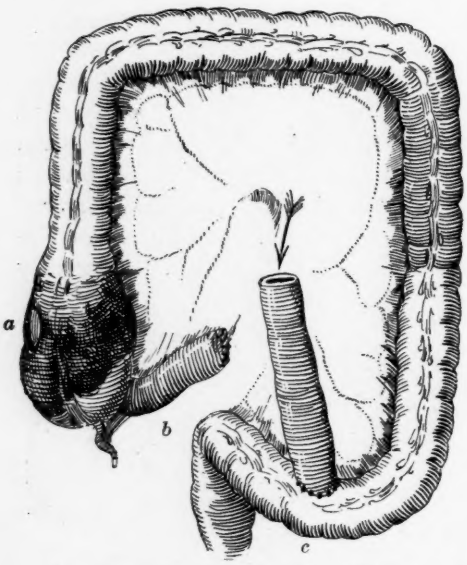

FIG. 138.—Illustrating the condition in the second case after the operation for exclusion of the cæcal growth.

a, Opening into centre of growth; *b*, Lower end of ileum divided and closed; *c*, Anastomosis of upper end of ileum to middle of sigmoid.

For two or three days the patient was much improved; but at the end of this respite the obstructive symptoms returned, and it was necessary to open the abdomen. Some blood-stained fluid was found free in the peritoneal cavity, and the lower coils of the small intestine were much distended and thickened. The growth involved the large bowel from just above the ileocæcal valve almost to the hepatic flexure. It was quite fixed, and there were many deposits on the peritoneum in its immediate vicinity. Removal was out of the question, and the first thing that occurred to me was to make a lateral anastomosis between the ileum and a convenient portion of the colon beyond the growth. However, from previous experience I knew that such an anastomosis would not prevent a fæcal fistula, in the presence of the direct opening which existed. Further, I expected that the cæcal opening would become larger as the growth advanced, and that although the amount of fæcal discharge was small, it might at any time become very troublesome. The ileum was therefore divided about a foot from the cæcum, and the upper end implanted into the sigmoid, as the most convenient portion of bowel available. The distal end of the divided ileum was then completely closed, leaving the parts as shown in *Fig.* 138. The patient made a good immediate recovery, and left hospital feeling comfortable and well.

On Jan. 26, 1914, just nine weeks after the last operation, he was re-admitted as an abdominal emergency, his medical attendant having made a diagnosis of ruptured duodenal ulcer. The patient stated that after leaving hospital his condition steadily improved, the bowels acted regularly, he had a good appetite, and was able to return to work. A little pus was discharged from the fistula in the

* "Malignant Disease of the Colon associated with Abscess, simulating Appendicitis," *Edinburgh Medical Journal*, 1909, Dec.

cæcal region, though there was never any definite fæcal matter, and the opening was gradually becoming smaller. On the day before admission he had breakfast as usual, but at 11 a.m. he was suddenly seized with severe abdominal pain, which made him vomit and feel very ill. The pain continued all day, but he did not send for his doctor. He had a very bad night, but in the early morning the pain became easier and he got a little sleep. About 8 a.m. the severe pain returned, and after being visited by his medical attendant he was at once sent into hospital.

When I saw the man, he was obviously very ill, with a pinched grey face, a pulse of 120 per minute, and an exceedingly dry tongue. The abdomen was intensely rigid all over, and very tender, especially in the lower part. The picture was typical of perforative peritonitis, and had it not been for the previous knowledge of the presence of a growth, the diagnosis of ruptured duodenal ulcer would have been very probable.

At the operation, I made a median incision below the umbilicus. There was a large quantity of thin purulent fluid in the abdomen, but without intestinal contents, and the coils of the lower bowel were distended and reddened. The neighbourhood of the anastomosis was first examined, but there was no sign of perforation. Towards the upper abdomen the peritonitis was less, and both stomach and duodenum were found to be perfectly normal. The growth was larger than at the previous operation, but there was no sign of perforation or sloughing. The blind lower end of the ileum was next examined, and was found to be distended to three or four times its normal size, and to be congested and thickened; there were several small yellowish areas, as though the wall were sloughing, but there was no actual perforation (*Fig.* 139). As this was obviously the cause of the peritonitis, it was brought outside the wound and opened. It contained a large amount of foul-smelling material, and its mucous surface was œdematous and intensely congested. In view of the serious condition of the patient, it was necessary to adopt the simplest expedient; and therefore a Paul's tube was tied into the opened extremity of the cul-de-sac, which was fixed to the lower end of the incision, and after irrigation of the peritoneal cavity the abdomen was closed.

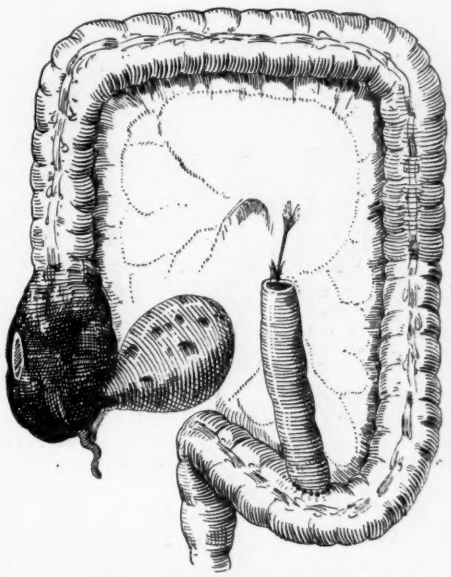

Fig. 139.—Illustrating the condition in the second case as found at the third operation. The lower end of the ileum is enormously distended as the result of obstruction, its walls are thickened from inflammation, and there are numerous areas on the point of perforation.

The man again made a rapid recovery, and was able to leave the hospital at the end of a fortnight, with, of course, a mucous fistula where the bowel was attached to the surface. Unfortunately the growth steadily progressed, and death occurred soon afterwards.

The explanation of the case is obvious. After the short-circuiting operation, the growth gradually involved the ileocæcal valve, causing complete obstruction, so that the excluded portion of ileum could not empty its contents into the large bowel. The secretion collecting in the cul-de-sac became infected from the ulcerating growth, the subsequent events being the counterpart of what occurs in acute appendicitis.

When the short-circuit was made and the lower end of the ileum excluded,

I did not anticipate that the growth would obstruct the ileocæcal valve, and in fact I inferred that, as it progressed, there would be a freer exit through the fistula on to the abdominal wall. Had the actual course of events been foreseen, it would have been best simply to have made a lateral anastomosis without dividing the ileum, so that the contents of the latter between the anastomosis and the valve could regurgitate to the new opening in the event of obstruction supervening.

This case illustrates a rather unusual series of events, but it is quite common to have to deal with an irremovable growth in either the hepatic flexure, the transverse colon, or the splenic flexure. Under these circumstances it is often difficult to get the cæcum across to the descending colon or to the sigmoid—undoubtedly the best plan if it can be carried out (*Fig.* 140).

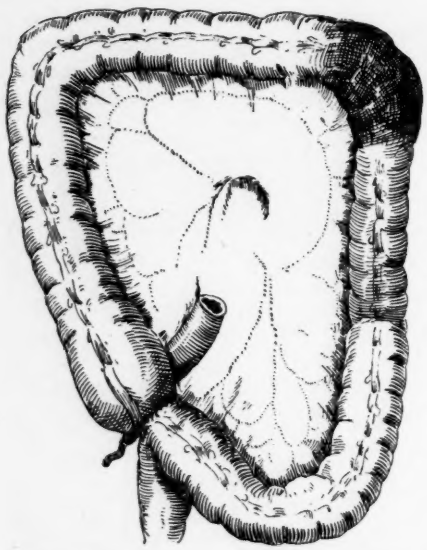

FIG. 140.—Illustrating lateral anastomosis of the cæcum to the sigmoid for irremovable malignant growth at the splenic flexure.

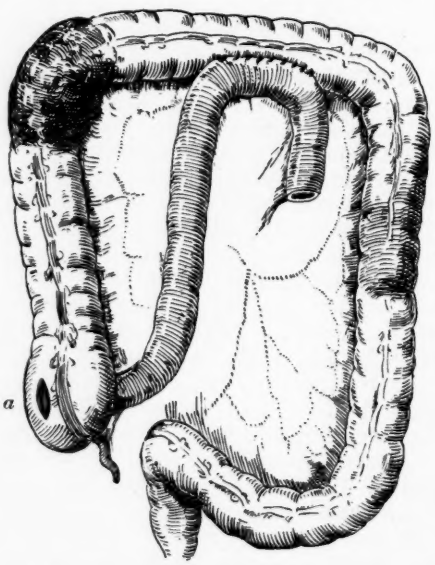

FIG. 141.—Illustrating lateral anastomosis between ileum and transverse colon in a case of irremovable malignant growth at the hepatic flexure. A cæcostomy is also necessary to guard against rupture of the cæcum from over-distention. *a*, Cæcostomy opening.

Of course there is a great temptation—and in fact it is often the only possible measure—to join the ileum to some part of the large bowel beyond the growth (*Fig.* 141), and no evil consequences need follow provided the ileocæcal valve proves incompetent. In about one case out of every three the valve is competent, and then the large bowel between the valve and the growth may become so distended with mucus that it either causes repeated attacks of painful spasm, or, if it cannot find an exit through the growth, it may cause the cæcum to burst, as in the first case. Fortunately a preliminary cæcostomy has often been necessary, and in spite of the entreaties of the patient it must be allowed to remain, as it provides a permanent safety-valve. Should an opening into the cæcum not exist, the surgeon must either unite the cæcum to the large bowel beyond the growth, or make an anastomosis between the

ileum and the distal colon. In the latter case, either an opening must be made into the cæcum just large enough to let out the gas and mucus, or a plastic operation must be performed on the ileocæcal valve in order to render it incompetent.

The difficulty of foreseeing and providing against all the possible evil results that may follow short-circuiting operations in cases of malignant disease of the cæcum or ascending colon, has led me in several instances to remove such growths merely as a palliative measure. The results have been exceedingly good, and have in my opinion amply justified the adoption of this plan. In one case it was necessary to remove a portion of the infiltrated anterior abdominal wall, together with over six feet of small bowel which was adherent to the growth, as well as the cæcum and colon to a point beyond the hepatic flexure. This patient not only made a rapid recovery, but returned to his work until death supervened from apoplexy twelve months later. There was no examination after death, but there were never any symptoms suggesting local recurrence.

ANATOMICAL LOCALIZATION OF A METALLIC FOREIGN BODY AND RECONSTRUCTION OF ITS TRACK.*

By Captain P. T. CRYMBLE, R.A.M.C. (T.F.)

Since the outbreak of the war numerous papers have been published describing methods of determining the position of a fragment of metal in the body, the position being expressed in centimetres in relation to some skin point. The object of this contribution is to show that it is possible to combine these radiographic results with sectional anatomy, and thus determine the actual anatomical position of the foreign body. It is advisable that the radiographic examination should be carried out with this object in view, since some of the methods in common use cannot yield the required information. For instance, consider the case of a piece of metal in close relation to the bony wall of the iliac fossa: here the bone is only a few millimetres thick, and it would be quite impossible from a screen examination to state whether the foreign body is ventral or dorsal to the bone; and yet without this information the surgeon would be seriously handicapped in an operation for its removal.

Anatomical localization is rarely necessary in dealing with the extremities, and the determination of the nearest skin point by screen examination will suffice. Where, however, there is intimate relation to bone or to the large vessels, the more complete examination should be carried out.

A further development arising from the association of sectional anatomy and radiography is the reconstruction of the track of the missile. This suggestion has received a considerable amount of criticism, it being stated that metal fragments or bullets do not take a straight course through soft tissues. One has, however, seen little evidence in support of the latter view, whereas a large number of post-mortem examinations have demonstrated the straight course. It is entirely a different matter where bone intervenes, but in this case a rallying point will be obtained in the radiogram.

Again, it has been stated that unless one knows the posture of the patient during injury, and has a correspondingly sectioned body, the reports will be seriously vitiated. This criticism can only apply to those parts of the body where the relation of entry wound to exit wound or foreign body may change. This is most marked in the region of the hip and shoulder-joints, but it also applies, in a much smaller degree, to the abdomen and neck. Undoubtedly it is a source of fallacy; nevertheless it will be shown that valuable information can be obtained in all these regions.

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* Read before the Etaples Medical Society in January, 1916.

METHOD.

Serial sections, or illustrations of serial sections, of the body are required, and the following have been used in this department :—

1. Coronal sections and a lateral reconstruction of the head of a man, age 59 (referred to as Man 59), life size, prepared by Professor Symington.

2. Fifteen horizontal sections through the abdomen and pelvis of a man, age 50 (referred to as Man 50), life size, prepared by P. T. Crymble.

3. *Cross Section Anatomy*, by Eycleshymer and Schoemaker (Appleton & Co.).

Anatomical Position of the Entry Wound.—The vertical position is easily correlated with some suitable bony point, the iliac crest being used for the abdomen and the sternum and costal cartilages for the thorax. In the neck the thyroid and cricoid cartilages are suitable landmarks. A piece of fuse wire fixed to the entry wound during the plate exposure correlates the entry wound with the vertebræ.

The lateral position is noted as being so many centimetres from the mid-line, and as being on the anterior or posterior aspect of the body. Wounds on the lateral surface may be described as being vertically above a definite point on the iliac crest at a certain distance from the superior iliac spines.

In dealing with the abdomen, the transpyloric, intertubercular, and lateral lines will be found of great use; whilst the ribs and interspaces will assist in thoracic cases.

In head wounds, the following points can be easily transferred to the reconstruction : nasion; inion; external auditory meatus; mastoid process; zygoma; sagittal suture; malar tubercle; orbital margins.

Screen Examination.—It is advisable in thoracic and abdominal cases to determine the vertical and lateral positions of the metal fragment by use of the fluorescent screen, as otherwise one may easily fail to include the foreign body on the plate; respiratory movement of the missile may also be detected; and movements produced by the heart-beat will demonstrate the presence of a piece of metal embedded in the heart or in contact with it. In the neck, screening may disclose movement of the metal during deglutition. Of special importance in the extremities is the point of maximum movement produced by prodding the circumference of the limb with a pencil. This determines the shortest route for removal.

Stereoscopic Radiograms.—These are taken with the foreign body vertically under or over the crossing of the plate-carrier wires. The tube is moved through a distance of 6 cm. between the two exposures, the first exposure being made with the tube anticathode 3 cm. to one side of the vertical line passing through the foreign body and the crossing of the wires. Since the detection of bone injury will modify the track reconstruction, the area intervening between the entry wound and the foreign body should be included in the plate examination.

Examination of the Plates.—If the piece of metal is found in close relation to any bone, no further examination is necessary; but if this close relation does not exist, the distance between the foreign body and the cross wires is determined by reconstructing the paths of the rays.

Anatomical Localization.—Knowing the vertical and lateral positions of the foreign body, its site is marked on a reconstruction of the part of the body concerned, and the corresponding section selected. Application of the depth measurement or bone relations to the surface of this section decides the actual anatomical structure occupied by the foreign body.

Reconstruction of the Track.—On a reconstruction viewed from the anterior aspect, and on another reconstruction viewed from the lateral aspect,

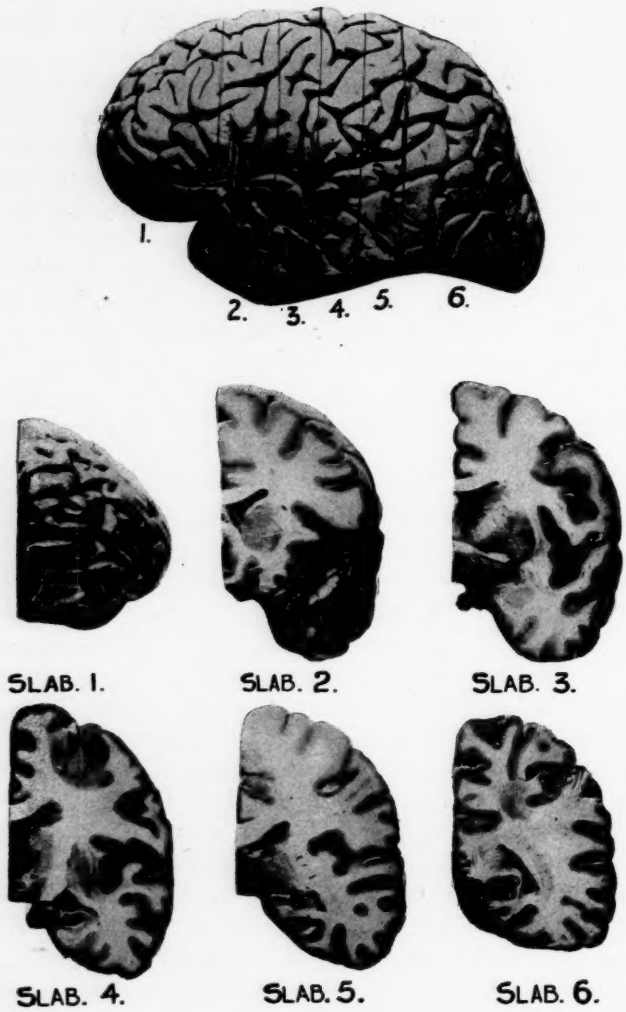

FIG. 142.—The left cerebrum of a man, age 59, viewed from the lateral aspect. Prepared, photographed, and cut into a series of coronal slabs by Professor Symington. The anterior aspects of the six slabs are shown. The whole series is reproduced on a scale of one-third. It would be advisable in using this series to enlarge to natural size, and to measure from the middle line.

The following structures are exposed: *Slab I.*—Frontal pole; *Slab II.*—Anterior horn of lateral ventricle, anterior end of corpus striatum, and island of Reil; *Slab III.*—Caudate and lenticular nuclei, and internal capsule; *Slab IV.*—Optic thalamus, internal capsule, lenticular nucleus, body of lateral ventricle, descending horn of lateral ventricle; *Slab V.*—Optic thalamus, fornix, body and descending horn of lateral ventricle; *Slab VI.*—Posterior horn of lateral ventricle.

the entry wound and metal fragment are marked. If no bone lesion is present, the wound and the foreign body are connected by a straight line. Where a bone lesion is present, the wound is connected to the bone lesion by a straight line and the bone lesion is connected to the foreign body by another straight line. Reference to the anterior reconstruction will then give the lateral position of the track in any section, and reference to the lateral reconstruction will give the sagittal or anteroposterior position in any section.

The Head.—Anatomical localization of foreign bodies in the head is of extreme importance in prognosis and treatment, and is a means of studying the functions of the brain.

It is advisable to subdivide the head into three parts :—

A. *The Scalp and Temporal Muscles.*—Fragments of metal embedded in

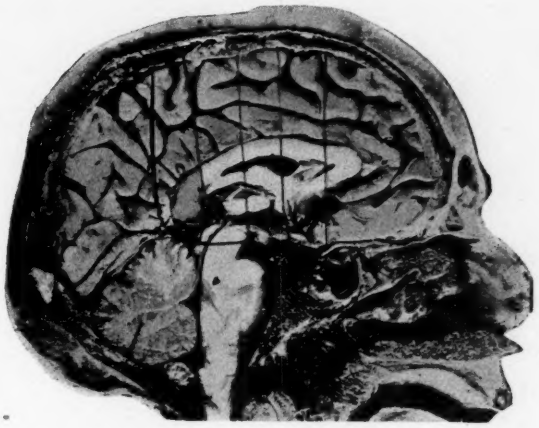

FIG. 143. — Medial aspect of the left half of the head of Man 59. Prepared by Professor Symington. It shows the position of the coronal sections, and has been used in making the radiographic enlargement, *Fig.* 144. (×$\frac{1}{3}$.)

the scalp present little difficulty when they are of reasonable size, since they usually lie near the wound of entry and are often palpable. Considerable difficulty may, however, be experienced in removing a minute fragment, and such a case should be localized on the screen.

B. *The Facial Portion of the Skull.*—This comprises the maxillæ and the

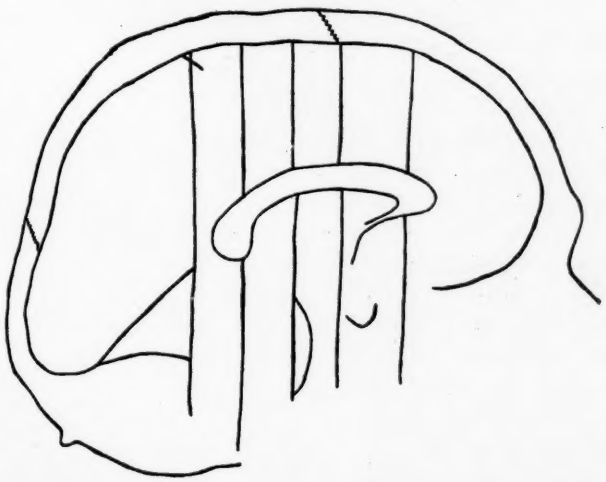

FIG. 144.—The main features of *Fig.* 143 enlarged to radiographic size. The periphery of the skull, the periphery of the cerebrum, the bregma, the lambda, the glabella, the inion, the tentorium, the upper end of the central fissure, the corpus callosum, the anterior surface of the pons, the pituitary gland, and the coronal sections are marked. This is the left stereoscopic radiogram. (× $\frac{1}{3}$.)

orbits. Lateral stereoscopic radiograms will, as a rule, enable one to give a satisfactory report, since the metal has usually a close relation to bone. In the case of the orbit, the Mackenzie Davidson method should be applied.

C. *The Brain-Case.*—The object of our examination here is to determine the presence or absence of a fracture, and the position and nature of abnormal

cranial contents, such as bone particles, metal fragments, gas, or pus. The anatomical position of the entry wound should be noted, using landmarks which are figured on the reconstruction; lateral stereoscopic radiograms and a single anteroposterior radiogram are taken; and the results are transferred to a reconstructed head. The anteroposterior radiogram enables one to determine

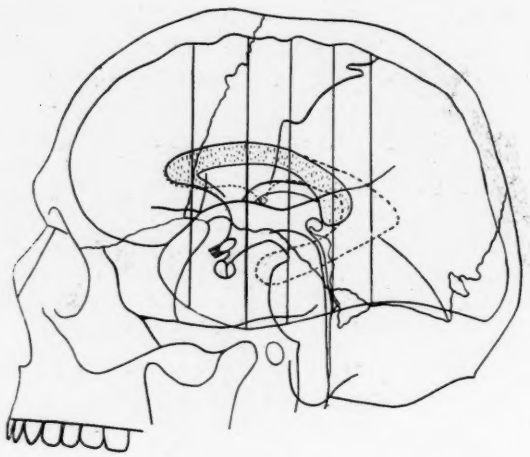

FIG. 145.—Reconstruction of the left half of the head of Man 59, viewed from the left. Prepared by Professor Symington. The following are figured: The skull sutures; The central and Sylvian fissures; The outline of the cerebrum, pons and medulla, and mid-brain; The corpus callosum, fornix, optic chiasma, and pituitary gland; The lateral ventricle (dotted line) with its anterior, posterior, and descending horns, and the foramen of Monro; The coronal sections. (× ⅓.)

the lateral position of the foreign body by reconstructing the ray paths, and in the lateral stereoscopic pictures one seeks for signs of fracture and determines the vertical and sagittal positions of abnormal intracranial contents. Stereoscopic pictures have been found essential in interpreting the various patho-

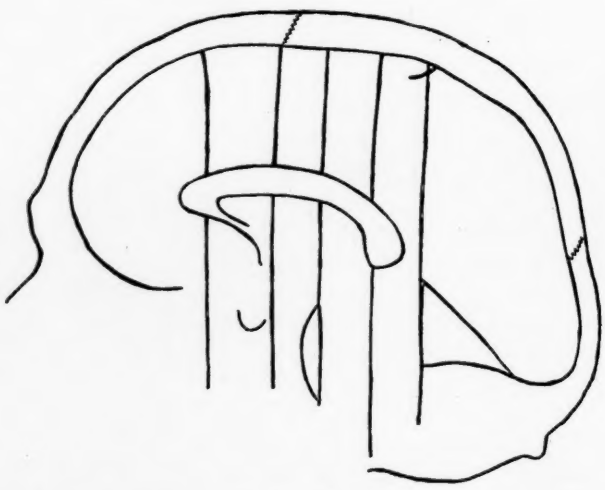

FIG. 146. — Left stereoscopic enlargement of *Fig.* 145, showing the same structures as are shown in *Fig.* 144. (× ⅓.)

logical conditions of the skull, and the lateral picture is so much more easily obtained than the anteroposterior that one has selected it as a routine.

The lateral stereoscopic radiograms are taken with the median sagittal plane of the head parallel to the table, the transverse cross wire parallel to the nasio-inion line and half an inch superior to it, and the vertical cross wire pass-

ing through the head of the mandible. This position can be obtained by elevating the head on cotton-wool pads, and fixation is procured by a broad

FIG. 147. — Left stereoscopic radiogram of *Case* 685, with the radiographic enlargement shown in *Fig.* 144 superimposed upon it. (× ⅓.)

An anteroposterior radiogram having shown that the intracranial piece of metal was in the middle line (*Fig.* 148), and the lateral stereoscopic plates having demonstrated that the posterior piece of metal was intracranial, the superposition at once showed that the splenium of the corpus callosum was the anatomical site of the metal fragment. The three other pieces of metal were extracranial.

Man 59 is more dolichocephalic than *Case* 685, but otherwise the superposition is excellent – cf. the bregma, pituitary fossa, periphery of the cerebrum, and the lower part of the occipital bone.

bandage secured by sand-bags and the pressure of the over-table plate-carrier. The tube is under the table and moves transversely. The distance between the anticathode and the plate is about 60 cm.

FIG. 148.—Anteroposterior radiogram of *Case* 685, showing a piece of metal in the middle line. A ring of fuse wire has been placed on the inion.

INTERPRETATION OF THE RADIOGRAMS.—Considerable difficulty was at first experienced in transferring the foreign body shadow from the lateral radiogram to the lateral reconstruction, since, owing to distortion and enlargement, the radiogram could not be superimposed upon the reconstruction. The difficulty was overcome by preparing a radiographically enlarged lateral reconstruction.

A drawing of a median sagittal section of the head was taken, and fuse wire applied to the following lines :—

1. The outline of the skull
2. The outline of the cerebrum
3. The bregma, lambda, and inion
4. A series of coronal sections through the cerebrum
5. The outline of the pituitary gland

6. The tentorium cerebelli
7. The outline of the corpus callosum
8. The anterior surface of the medulla
9. The upper end of the central fissure (Fissure of Rolando).

The drawing prepared in this way was then placed at a distance of 50 cm. from the anticathode and radiographed stereoscopically, with the plates at a distance of 60 cm. The resulting pictures, right and left, can now be accurately superimposed upon the right and left radiograms respectively, and the relation of the foreign body to any of the marked structures disclosed. The distance of 50 cm. was selected because the median sagittal plane of the head was found to be as a rule that distance from the anticathode.

Case 343.—(See *Figs.* 149–152.)

HISTORY.—Wounded by a portion of a hand grenade on Nov. 19, 1915. The grenade burst in the air, and the patient was standing when he received the wound.

RADIOGRAPHIC REPORT, Nov. 23.—The missile has passed through the upper part of the left pinna, and has entered the scalp 1·5 cm. posterior to the junction of the helix with the scalp, and on the same horizontal level as the upper margin of the pinna.

A single anteroposterior and two lateral stereoscopic plates were taken, which showed a piece of metal the size of a pea lodged in the middle line 3 cm. inferior to the dura and 1·5 cm. posterior to the bregma.

Anatomical Localization.—Piece of metal embedded in the falx cerebri 3 cm. inferior to the dura and 1·5 cm. posterior to the bregma.

Track Reconstruction.—Reference to the Eycleshymer and Schoemaker atlas showed that the track lay in Sections 8 to 3 inclusive and was as follows :—

Sec. 8.—Perforates the squamous temporal bone.
Sec. 7.—Perforates the temporal lobe.
Sec. 6.—Perforates the island of Reil.
Sec. 5½.–Perforates the upper part of the putamen of the lenticular nucleus.
Sec. 5.—Perforates the corona radiata, the corpus callosum, and possibly the anterior horn of the lateral ventricle.
Sec. 4.—Perforates the callosal gyrus.
Sec. 3.—Embedded in the falx cerebri.

CLINICAL REPORT.—Right hemianæsthesia.

OPERATION.—Skull opening enlarged and a small spicule of bone removed.

POST-MORTEM EXAMINATION (some weeks later).—A small piece of metal was found embedded in the falx cerebri overlying the callosal gyrus (see *Fig.* 150). Horizontal sections were made through the left cerebral hemisphere, and exposed the following :—

Large cortical defect surrounding the peripheral end of the track, and situated in the temporal lobe. From this cavity the track passed upwards, forwards, and medially, close to the posterior limit of the island of Reil, through the external capsule, through the lateral part of the lenticular nucleus, through the corona radiata, and finally emerged on the surface of the callosal gyrus.

A small secondary track, beginning in the cortical defect and terminating blindly, was seen in relation to the island of Reil. Possibly it was a false passage produced at operation, or it may have lodged a spicule of bone or other foreign body.

The anterior horn contained pus and communicated with the track, but it could not be determined whether this communication was primary or secondary. The terminal portion of the track and the region occupied by the metal fragment were macroscopically free from infection. All that part of the track peripheral to the callosal gyrus contained pus.

REMARKS.—This case shows the possibility of reconstructing the track, and of determining the anatomical position of the missile. Clinically the only sign was right hemianæsthesia, probably due to division of fibres from the postcentral gyrus,

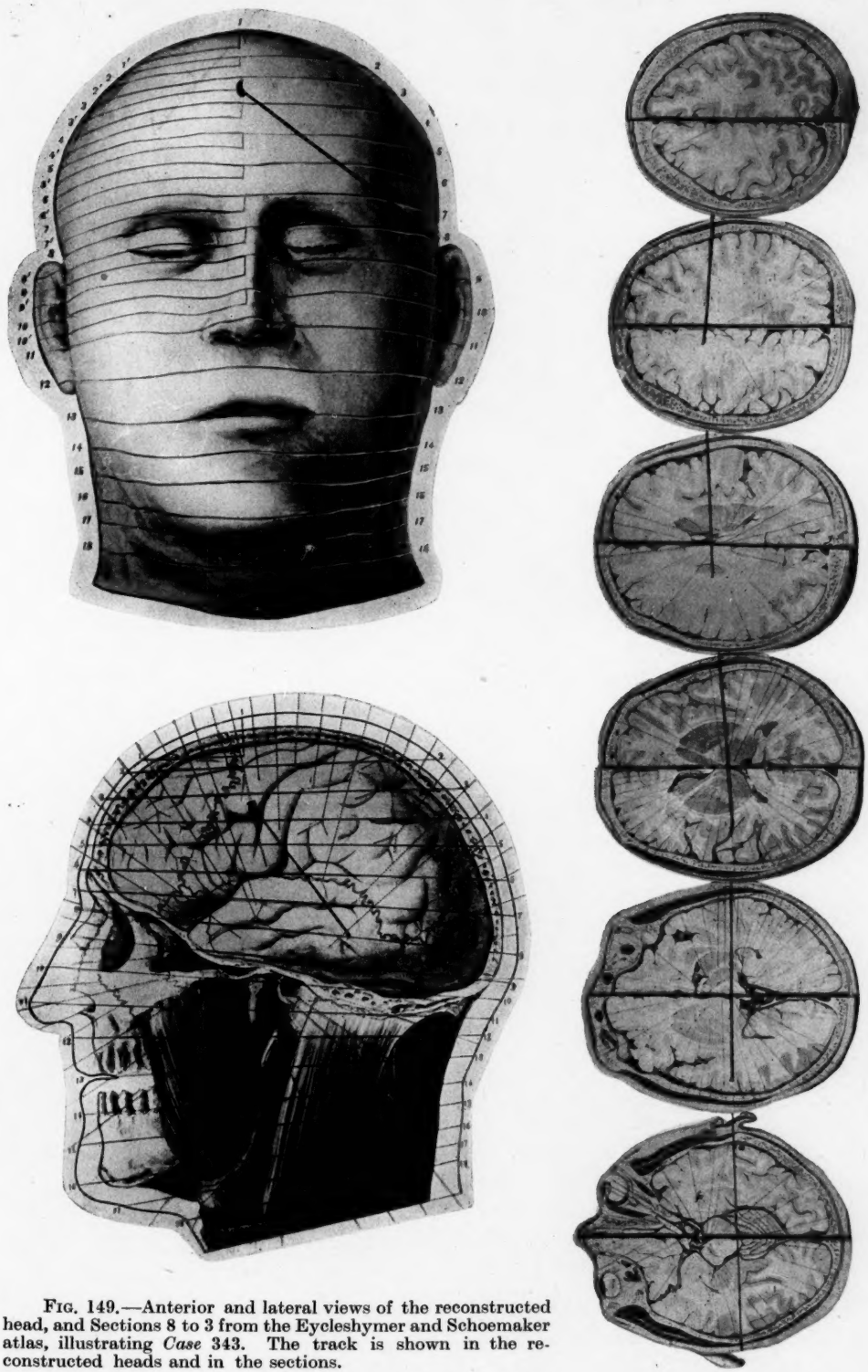

FIG. 149.—Anterior and lateral views of the reconstructed head, and Sections 8 to 3 from the Eycleshymer and Schoemaker atlas, illustrating *Case* 343. The track is shown in the reconstructed heads and in the sections.

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although at the same time it is worth noting that the callosal gyrus was at one time held to be a seat of cutaneous sensation.

The complete absence of pus in the terminal portion of the track and in the neighbourhood of the foreign body was very striking, and it was evident that the prolonged presence of the metal fragment had been well borne by the tissues.

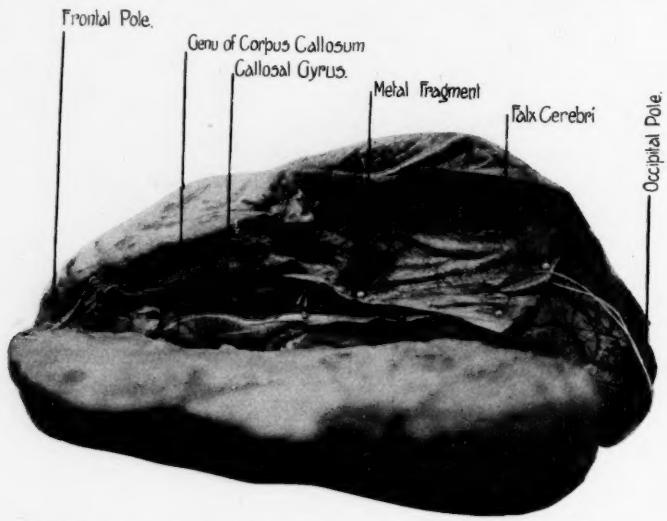

FIG. 150.—Brain of *Case* 343, showing the piece of metal embedded in the falx cerebri.

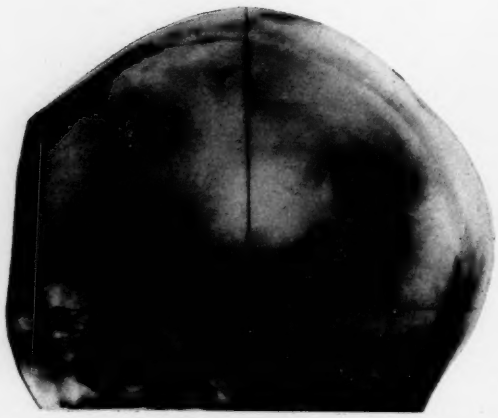

FIG. 151.—Lateral skiagram of *Case* 343, showing an intracranial piece of metal.

FIG. 152.—Anteroposterior skiagram of *Case* 343, showing the piece of metal in the middle line.

The Neck.—It is always advisable to make a screen examination in this region, to determine whether the metal fragment moves during deglutition or not. Anteroposterior radiograms should be taken with the head firmly fixed in the middle line, and since the cross wires cannot as a rule be brought in contact with the skin, a piece of fuse wire should be fixed on the skin over the foreign body, so that the depth may be determined.

Track reconstruction is more reliable in horizontal wounds, since the whole track will lie in one section, and movements of flexion and extension can be ignored. Injuries to the pharynx, larynx, trachea, œsophagus, spinal cord, nerves, and blood-vessels have to be sought for, and especially the last-mentioned, since in no part of the body is secondary hæmorrhage so difficult to deal with.

Case 923.—

RADIOGRAPHIC REPORT.—A piece of metal the size of a pea in the left side of the neck, at the level of the disc between the fifth and sixth cervical vertebræ, and in the same sagittal plane as the lateral margin of the transverse process. It lies opposite the middle of the thyroid cartilage, moves with deglutition, and is related to the posterior margin of the ala of the thyroid cartilage.

Track Reconstruction.—The entry wound is at the level of the body of the hyoid bone, and overlies the anterior margin of the right sternomastoid. No perforation of the carotid sheaths. Probable perforation of the larynx.

POST-MORTEM EXAMINATION.—The metal fragment traversed the right ala of the thyroid cartilage, the upper compartment of the larynx, the left arytenoid cartilage, the left sinus pyriformis, fractured the posterior margin of the left ala of the thyroid cartilage, and came to rest at the seat of fracture. It lay, with fragments of cartilage, in a blood cyst which communicated with the superior thyroid artery and with the sinus pyriformis. Death was due to secondary hæmorrhage into the sinus pyriformis.

Case 707.—

RADIOGRAPHIC REPORT.—Entry wound on a level with the hyoid bone and vertically below the angle of the mandible on the left side. A piece of metal slightly larger than a pea is lying anterior to the articular processes of the left side at the level of the disc between the fourth and fifth cervical vertebræ. The piece of metal has passed between the internal jugular vein and the internal carotid artery, producing an arterio-venous aneurysm.

The Thorax.—The large proportion of intrathoracic metal fragments are so inaccessible, and so many cases pursue a favourable course in spite of their presence, that operations for their removal have been rare in this hospital. Consequently the radiographic examination has been of more importance in diagnosing the various pathological sequelæ of the wound—e.g. hæmothorax, pneumothorax, empyema, lung collapse, or subphrenic abscess—than in determining the position of the foreign body.

Owing to the overlapping of the pleural and peritoneal cavities in the lower part of the thorax, a wound of this region frequently involves both these serous cavities and their contents, producing a very complicated pathological condition. Some cases may be cleared up by the discovery of an abnormal subphrenic gas bubble, and in others the track reconstruction is of extreme value. *Case* 807, where a piece of metal passed through the left pleural cavity, the diaphragm, and the spleen, lodging finally between the diaphragm and the left lobe of the liver, where it produced a left subphrenic abscess and a left empyema, is an illustration. The source of a hæmothorax may be suggested by the discovery of fractured ribs, or by the presence of the foreign body in the lung hilus. With the former condition the origin is probably parietal; with the latter a visceral origin is to be suspected.

No difficulty has been experienced in deciding the relation of the piece of metal to the rib, as it is always quite evident in the stereoscope. It is quite

otherwise with the central part of the body of the scapula, where the absence of structure renders the stereoscopic decision extremely difficult. The presence of a perforation may clear up the case.

Case 807.—

RADIOGRAPHIC REPORT, Feb. 21, 1916.—Entry wound 13·7 cm. to the left of the middle line, 16·2 cm. above the highest point of the iliac crest, and on the posterior aspect of the body. On the same horizontal plane as the entry wound—that is, the level of the eleventh thoracic vertebra—is a fragment of metal 2 cm. to the left of the middle line and 17 cm. in front of the posterior abdominal wall.

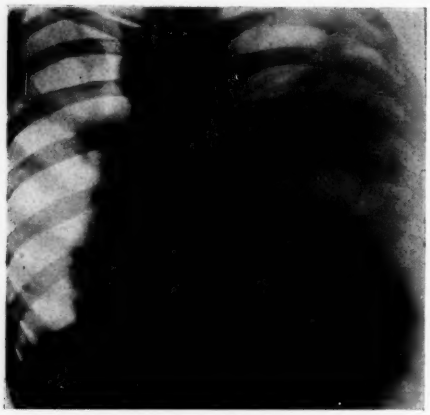

FIG. 153.—Skiagram of *Case* 440, showing a right hæmothorax, displacement of the heart and aorta to the left, and a piece of metal embedded in the root of the right lung.

Reference to *Slab* IX (Man 50), see *Figs.* 155 and 162, shows that the piece of metal is embedded in the left lobe of the liver close to the anterior abdominal wall, and that in reaching this position it traversed the left pleural cavity, the left lung, the diaphragm, the left anterior intraperitoneal subphrenic space, the spleen, the fundus of the stomach, and the liver.

Condition of the left thoracic cavity: marked displacement of the heart to the right; upper lobe of the lung collapsed and lying in the paravertebral groove; lower lobe somewhat collapsed and lying in contact with the posterior thoracic wall; pleural cavity contains fluid and probably gas.

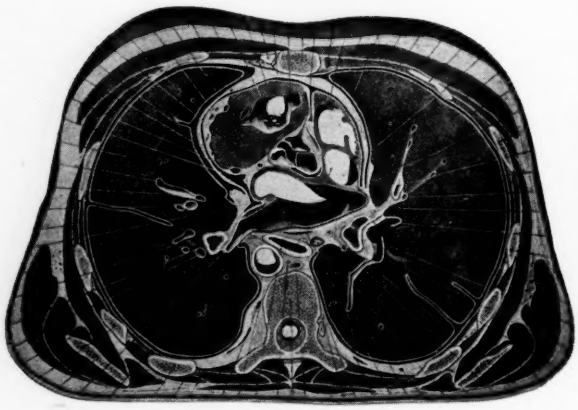

FIG. 154.—Horizontal section at the level of the piece of metal seen in *Case* 440, showing the foreign body opening into a large branch of the pulmonary artery,

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POST-MORTEM EXAMINATION, March 5.—Left empyema; loculated abscess lateral to the left lung apex; visceral and parietal pleuræ thickened, and separated from each other by a considerable space.

The entry wound opened into the lower part of the left pleural cavity. The diaphragm was perforated, the opening being plugged by a piece of omentum. The gastric border of the spleen was lacerated. The fundus of the stomach was uninjured. The piece of metal lay free in an abscess cavity, situated between the parietal surface of the left lobe of the liver and the diaphragm, and entirely isolated from the remaining portion of the peritoneal cavity by the falciform ligament and adhesions between the left lobe of the liver and diaphragm. There was also a collection of pus in that part of the subhepatic space lying to the left of the gall-bladder, and this second

abscess cavity was bounded on the right by adhesions connecting the liver and gall-bladder to the lesser omentum, and was bounded inferiorly by an adhesion connecting the stomach to the diaphragm and anterior abdominal wall. The pericardial cavity contained straw-coloured fluid, and the visceral pericardium was covered with shaggy white vegetations.

REMARKS.—It is interesting that, although the gastric border of the spleen was severely damaged, the fundus of the stomach escaped injury. It may be that a hollow viscus gives way before the impact of an almost spent missile.

The *x*-ray examination suggested subphrenic danger on Feb. 21, and yet it was not until March 4 that any ordinary clinical sign of peritoneal involvement appeared, although it was evident at the post-mortem that a large subphrenic abscess had been present for many days, probably for a duration equal to that of the empyema.

Left subphrenic abscess, therefore, is difficult to diagnose, especially when an empyema is present to account for the temperature, pulse, and other signs of severe illness. The pericarditis was secondary to the subphrenic abscess, as only a very thin layer of tendinous diaphragm intervened between the subphrenic abscess and the pericardial effusion.

The operation consisted in draining the pleural cavity. Pus and gas escaped.

Case 440.—(See *Figs.* 153, 154.)

RADIOGRAPHIC REPORT.—A piece of metal embedded in the root of the right lung. Heart and aorta displaced to the left side. Right hæmothorax.

POST-MORTEM REPORT.—A piece of metal embedded in the root of the right lung close to the medial end of the secondary fissure. Its bed communicated with a large branch of the pulmonary artery and also with the pleural cavity. This was a source of a secondary hæmorrhage which caused death.

Case 1044.—

RADIOGRAPHIC REPORT.—Entry wound 11 cm. to the right of the middle line on the posterior aspect of the trunk and 6·5 cm. above the inferior angle of the scapula. Fracture of the left seventh rib slightly posterior to its neck. Shrapnel ball lying immediately to the left of the disc between the eleventh and twelfth thoracic vertebræ.

Track Reconstruction.—The shrapnel ball passed transversely across the back, fractured the left seventh rib, entered the pleural cavity, and fell to the most dependent part of this cavity.

Reference to *Slab* IX (Man 50)—see *Fig.* 162—will show the present position of the foreign body.

REMARKS.—This was a difficult case to explain until one discovered the fracture of the left seventh rib. A straight line between the entry wound and the shrapnel ball would have involved the thoracic vertebræ, but they appeared normal.

Abdomen and Pelvis.—Only twenty-four abdominal cases have been radiographed in this hospital during the past eight months, and since none of these were operated on, and only three died, one has had few opportunities of reporting on such cases or of confirming one's reports.

This section of the paper is therefore necessarily somewhat theoretical. At the same time the problems which face the abdominal surgeon are well known, and it is evident that considerable difficulty may be experienced in answering any of the following questions :—

1. Has the missile penetrated the peritoneal cavity ?
2. What region of the cavum peritoneæ is involved ?
3. What portions of the alimentary tract have been injured ?
4. Is there any injury to the solid viscera, e.g. kidney, liver, spleen, or pancreas ?

One believes that track reconstruction will be found of great value in clearing up these problems; but it requires to be checked by the other means of

physical examination, since one labours under certain disadvantages in abdominal cases—viz., the visceral movement produced by respiration, change of posture, or distention of hollow viscera; the variation of visceral relations in different bodies; and finally the possibility of the foreign body changing its position through the action of gravity, inflammatory change, or peristaltic action. To compensate for these defects, however, one has large viscera and large cavities to deal with, so that a considerable margin of error is permissible.

It has seemed worth while to publish in this connection a complete series of sections through the abdomen of a man, age 50 (*Figs.* 162–76). A number of them were used in Quain's *Anatomy* (vol. ii, part 2), but the complete series has not previously been published. They are accompanied by an anterior reconstruction (*Fig.* 155) which was prepared by Professor Symington. For use in an *x*-ray department they should be enlarged to life size.

Case 111.—

A piece of metal embedded in the left obturator externus anterior to the ischium (see *Slab* XXII, *Fig.* 175). Reference to the section suggested the best route for removal of the foreign body. The pectineus was separated from the adductor longus and adductor brevis, and no difficulty was experienced in detecting the metal fragment or in removing it.

Case 441.—

Entry wound in the right tenth intercostal space on a level with the lower margin of the gladiolus and 15 cm. from the centre of the sternum. Large swelling at the wound. A piece of metal was localized in the iliac colon or in its walls, posterior to the crossing of the intertubercular and left lateral lines. It moved upwards and downwards during respiration, and could not be displaced from the iliac fossa by palpation. There was no rigidity of the abdominal walls.

Skiagrams taken on the following day showed complete disappearance of the metal fragment, so it must have been passed in a stool. Probably the fragment gained access to the lumen of the bowel at the hepatic flexure. An uninterrupted recovery was made.

Case 729.—(See *Figs.* 155–57, 164–67.)

Wounded Feb. 7, 1916, by a piece of shell.

Clinical History.—Loss of power in lower extremities. Knee-jerks absent. Anæsthesia inferior to the knees. Retention of urine and hæmaturia. Vomiting. Jaundice appeared on Feb. 14, and became more intense the next day. Death on Feb. 18.

Radiographic Report, Feb. 10, 1916.—Entry wound 3·4 cm. to the right of the middle line, 1·2 cm. superior to the highest point of the iliac crest, and on the posterior aspect of the trunk. A small piece of metal is situated on the transpyloric plane 6 cm. to the left of the middle line and 9 cm. anterior to the skin of the back. It lies on the same horizontal level as the first lumbar vertebra, and close to the upper margin of the eleventh rib. There is extensive fracturing of the second lumbar vertebra, involving the right inferior articular process, the spinous process, and the left transverse process and portion of adjacent body.

Track Reconstruction.—

Slab XIV (Man 50).—Erector spinæ.

Slab XIII (Man 50).—Right inferior articular process and spinous process of the second lumbar vertebra; the neural canal.

Slab XII (Man 50).—Left transverse process of the second lumbar vertebra; left psoas muscle; left kidney hilus; tail of pancreas or the spleen.

Post-Mortem Report.—The missile has passed through the right erector spinæ, through the neural canal at the seat of fracture, in front of the dura and its contents, and has perforated the lower pole of the left kidney. The metal fragment was found

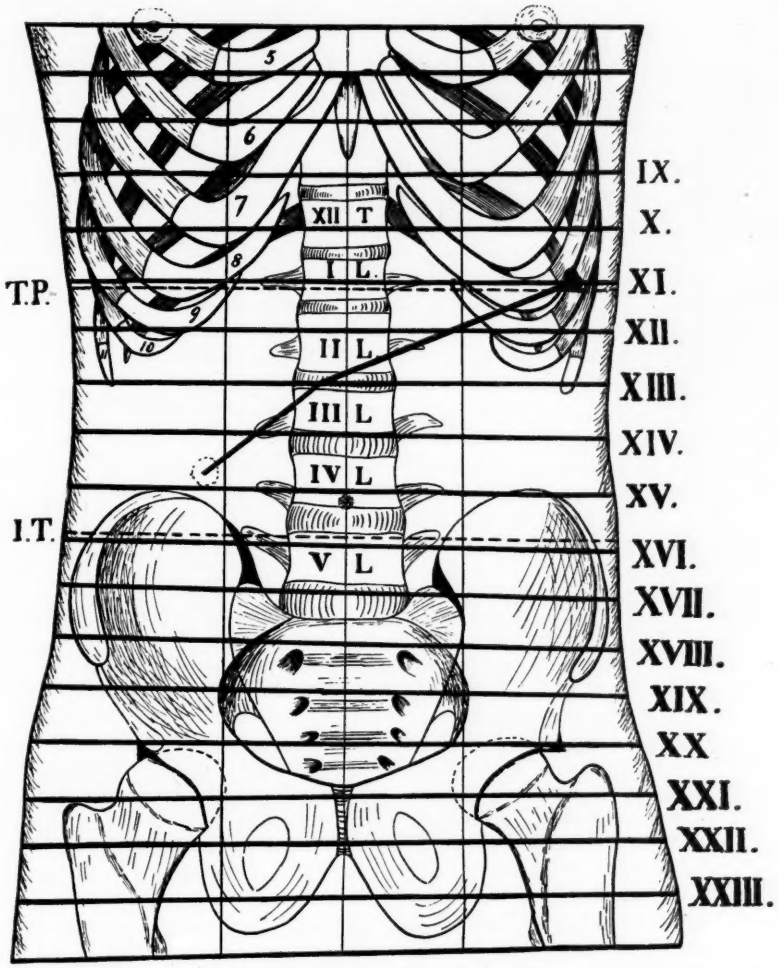

FIG. 155.—Anterior reconstruction of the abdomen of a man, age 50 years. (T. P.) Transpyloric plane. (I. T.) Intertubercular plane. The track of the missile in *Case* 729 is shown. The upper surfaces of *Slabs IX* to *XXIII* are illustrated in *Figs.* 162-76. (× ¼.)

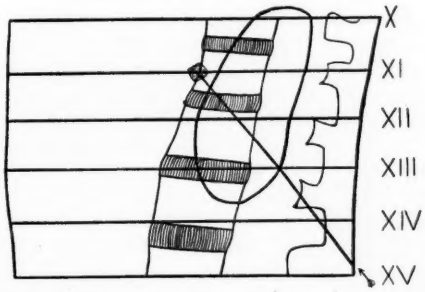

FIG. 156.—Lateral reconstruction of *Slabs X* to *XV*, showing the course of the missile through the kidney in *Case* 729. The vertebræ and spines are also shown. (× ¼.)

lying loosely at the junction of the diaphragm with the left costal margin. There was a large retroperitoneal hæmatoma on the left side, and a much smaller one on the right side. Surrounding the left kidney was a small quantity of sanious urine. The peritoneal cavity had not been perforated.

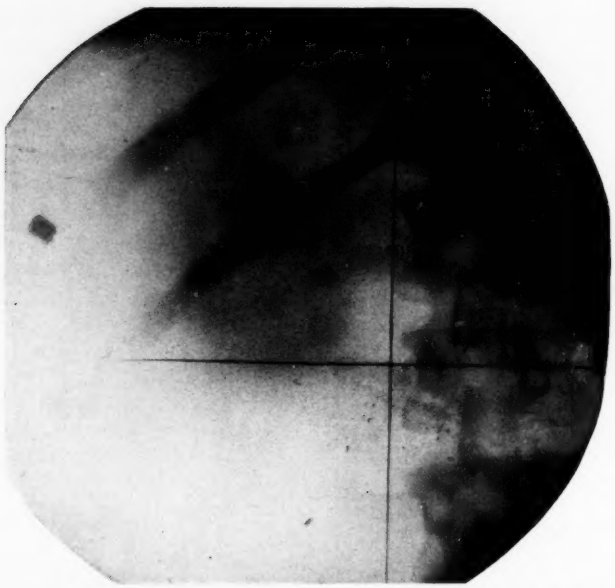

FIG. 157.—Radiogram of *Case* 729, showing the piece of metal and the injury to the second lumbar vertebra.

REMARKS. — It should be pointed out that the viscera in the Man 50 occupy a more inferior position than normal, and are still more peculiar in having a pancreas in contact with the lateral abdominal wall. The more average abdomen depicted in the Schoemaker and Eycleshymer atlas shows the missile passing from the kidney through perirenal fat to the eleventh rib; whereas in the Man 50 one would have to carry the track through the tail of the pancreas, the peritoneal cavity, and the spleen.

Case 386.—(*Figs.* 158–60, 169–71.)

CLINICAL HISTORY. — On Nov. 24, 1915, the patient was returning from the trenches, and whilst climbing over an obstacle received a severe blow in the back. He thought his back had been blown away with a shell and that his spine had been injured. He staggered back a few paces and fell. The range was estimated at 700 yards. For some time the left leg felt stiff and numb, and he was unable to move it. After six days he regained movement in the foot, and later in the knee. The lateral surface of the leg remained numb and the foot warm.

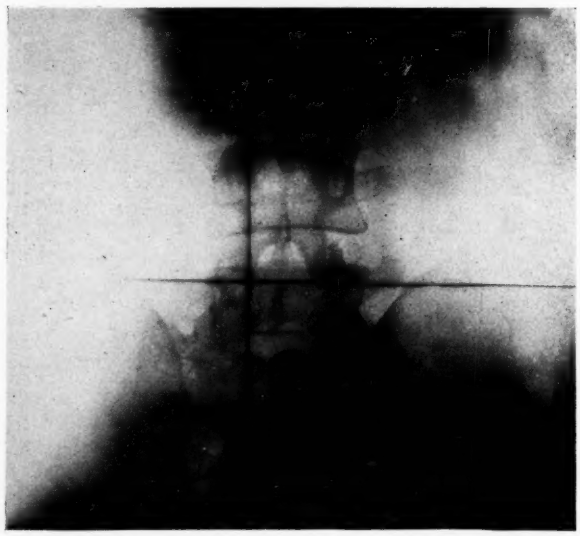

FIG. 158.—Radiogram of *Case* 386, showing a bullet embedded in the body of the fifth lumbar vertebra, and injury to the left sacro-iliac joint. The entry wound is marked by a ring of fuse wire.

Examination of the Left Leg, Dec. 3.—*Motor*: Normal movement in muscles supplied by the external popliteal. Some power in the quadriceps, but is unable to lift the heel from the bed. Slight power in the hamstrings, the glutei, and adductors. No power in the calf muscles. No reaction of degeneration. *Sensory*: Loss to light touch over the whole lower leg with the exception of a strip along the

medial side of the calf adjoining the medial border of the tibia. Loss to light touch over the posterior part of the thigh and gluteal region except the part immediately inferior to the iliac crest. To sum up the sensory condition, one may say that the whole of the lower extremity is anæsthetic to light touch, except the part supplied by the lumbar plexus.

RADIOGRAPHIC REPORT.—Entry wound lies on the left buttock, on a level with the anterior superior spine, and 8 cm. lateral to the middle line. Rifle bullet em-

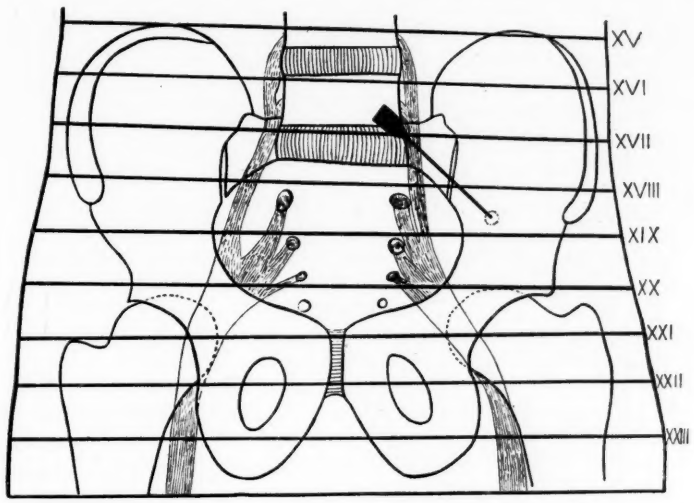

FIG. 159.—Anterior reconstruction of *Slabs XV* to *XXIII*, showing the track of the bullet in *Case* 386. (× ¼.)

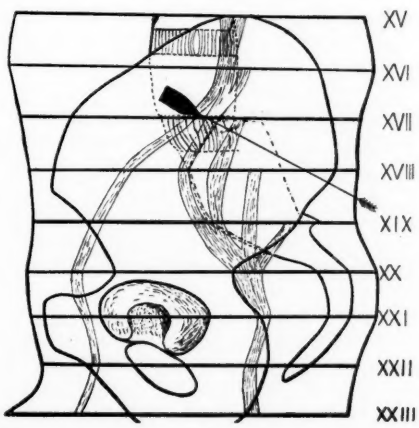

FIG. 160.—Lateral reconstruction of *Slabs XV* to *XXIII* (Man 50), showing the track of the bullet in *Case* 386. (× ¼.)

bedded in the left half of the body of the fifth lumbar vertebra. Some comminution of the bones entering into the left sacro-iliac joint.

Track Reconstruction.—The rifle bullet has passed through the left gluteal muscles, perforated the os ilium, the sacro-iliac joint, and the ala of the sacrum on the left side. It has then buried its base in the body of the fifth lumbar vertebra. The lumbosacral cord was the only nerve trunk lying in the immediate neighbourhood of the track.

REMARKS.—As is usual with bullets which perforate bone, this missile has finished its course passing base foremost, and it is shown in the sections as having turned round during its perforation of the os ilium. The only nerve trunk which is likely to have been divided is the lumbosacral, and it is possible that injury to the lumbosacral cord alone would give rise to the extensive anæsthesia and loss of power found in this case. On the other hand, the first sacral nerve must have been severely concussed by the passage of the bullet through the left sacro-iliac joint, and the second sacral to a lesser extent.

Case 600.—(*Figs.* 161, 175.)

Entry wound on the right buttock, so small that it at first escaped observation. Exit wound on the dorsum of the penis. Marked swelling of the scrotum. Stereoscopic radiograms of the pelvis showed a small notch on the lateral margin of the right ischium inferior to the acetabulum.

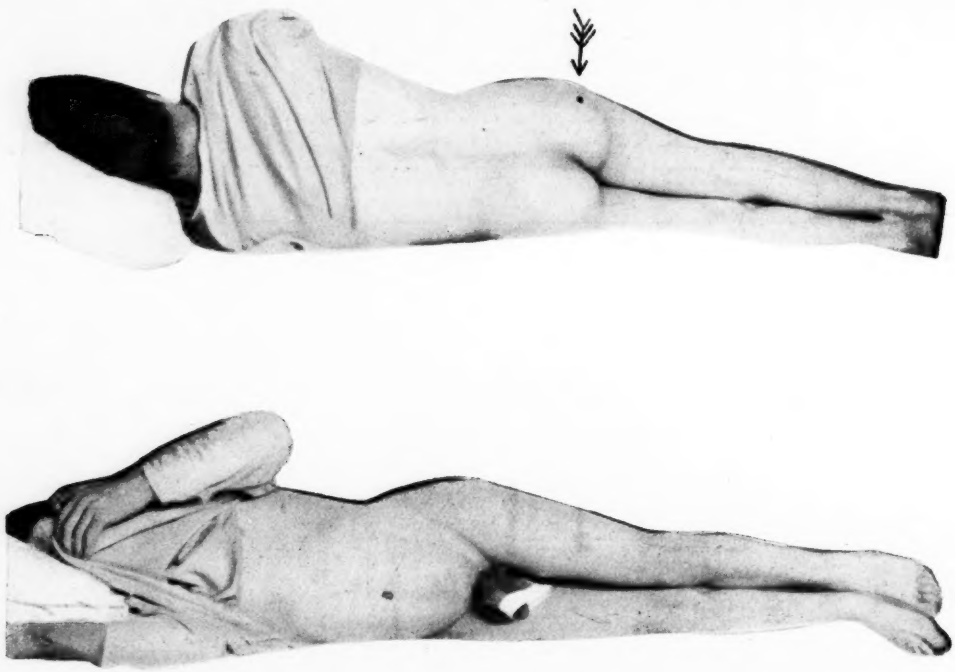

FIG. 161.—*Case* 600, showing the entry wound on the buttock and the exit wound on the dorsum of the penis.

Track Reconstruction.—Gluteus maximus, quadratus femoris, margin of ischium, obturator externus, adductor brevis.

The process of illumination in this case was as follows :—

1. The patient was sent to the radiographic department for localization of a foreign body alleged to have entered at the root of the penis.
2. Screen and radiograms showed nothing abnormal.
3. Further examination of the patient demonstrated the minute opening on the buttock.
4. Reference to *Slab* XXII demonstrated the probable track (see *Fig.* 175).
5. Further examination of the radiograms, and the discovery of the notching of the ischium, confirmed the above.

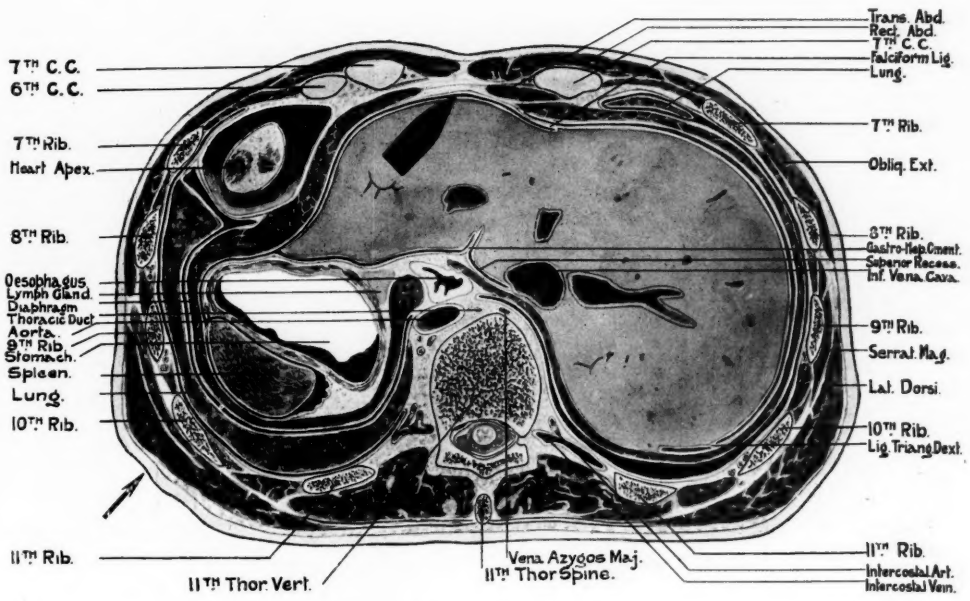

FIG. 162.—Upper surface of *Slab IX* (Man 50), showing the path reconstructed for *Case* 807. This section is of especial interest in subphrenic abscess. (× ⅓.)

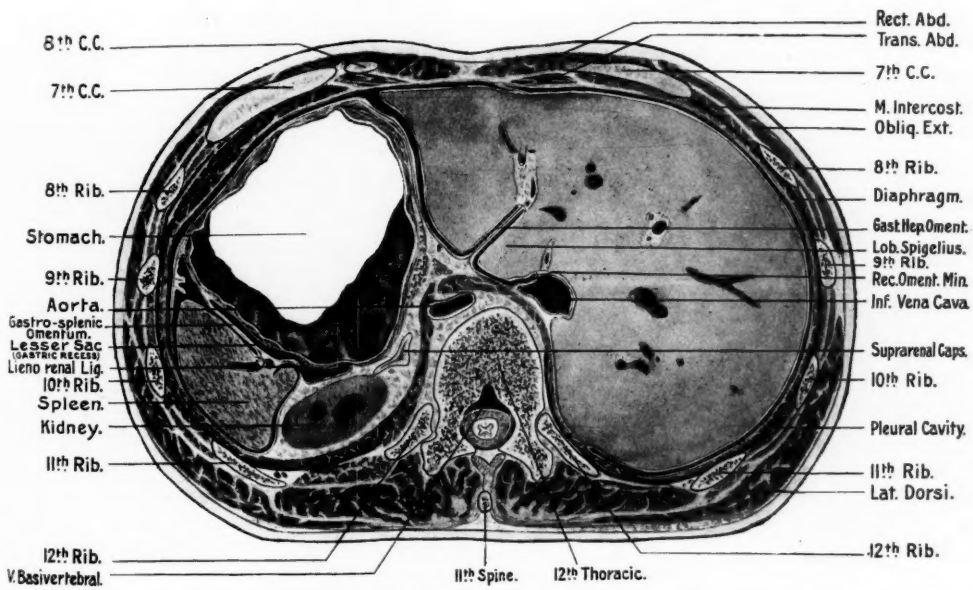

FIG. 163.—Upper surface of *Slab X* (Man 50). Stomach somewhat dilated. (× ⅓.)

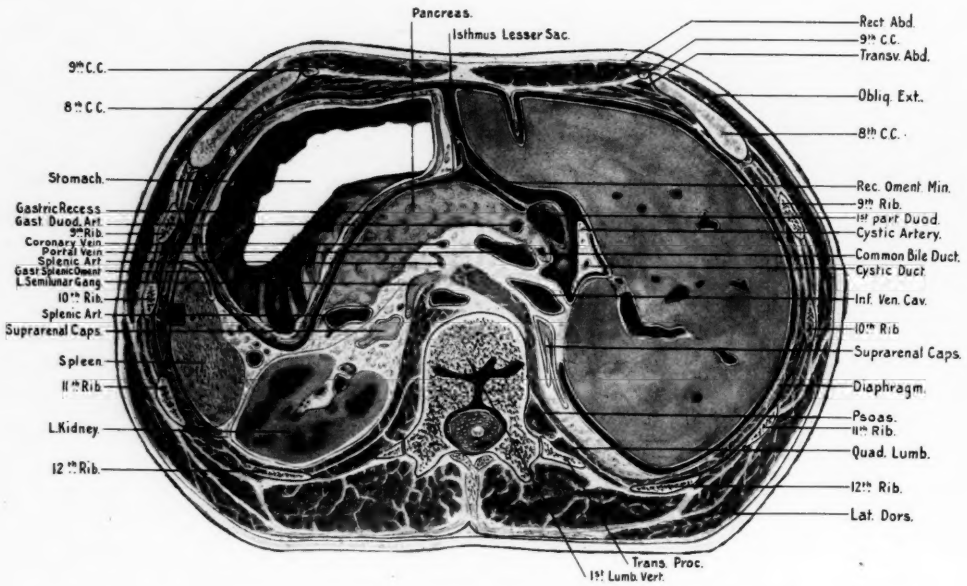

FIG. 164.—Upper surface of *Slab XI* (Man 50), showing the position of the missile in *Case* 729. This section passes through the transpyloric plane. (× ⅓.)

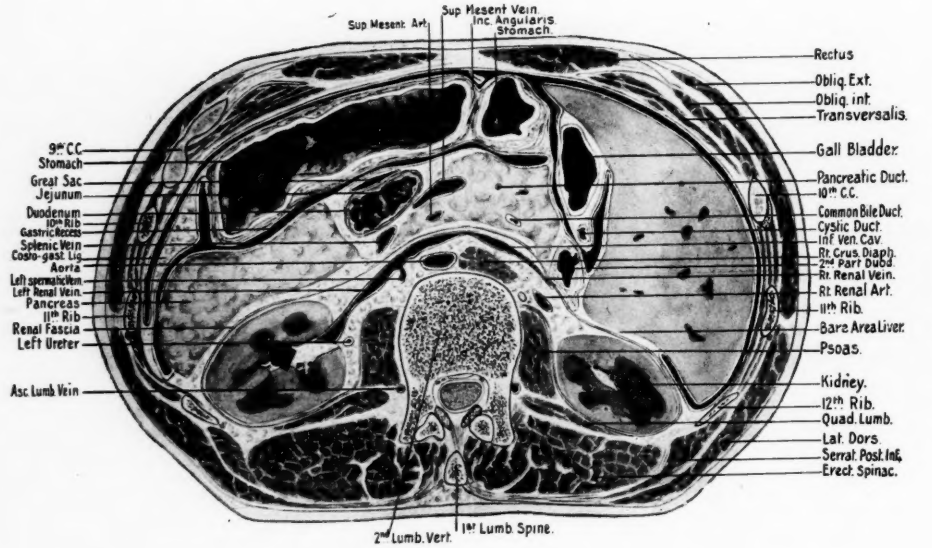

FIG. 165.—Upper surface of *Slab XII* (Man 50), showing the position of the missile in *Case* 729. (× ⅓.)

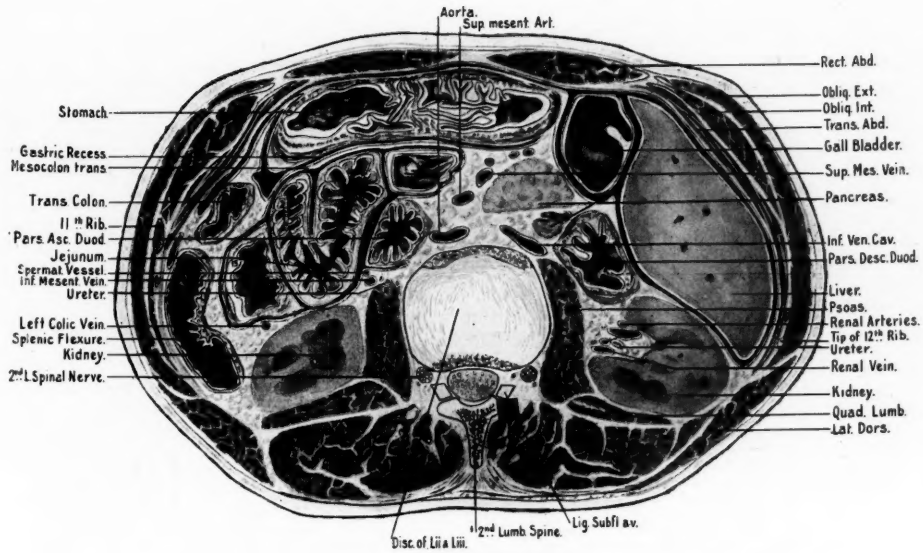

FIG. 166.—Upper surface of *Slab XIII* (Man 50), showing the position of missile in *Case* 729. (× ⅓.)

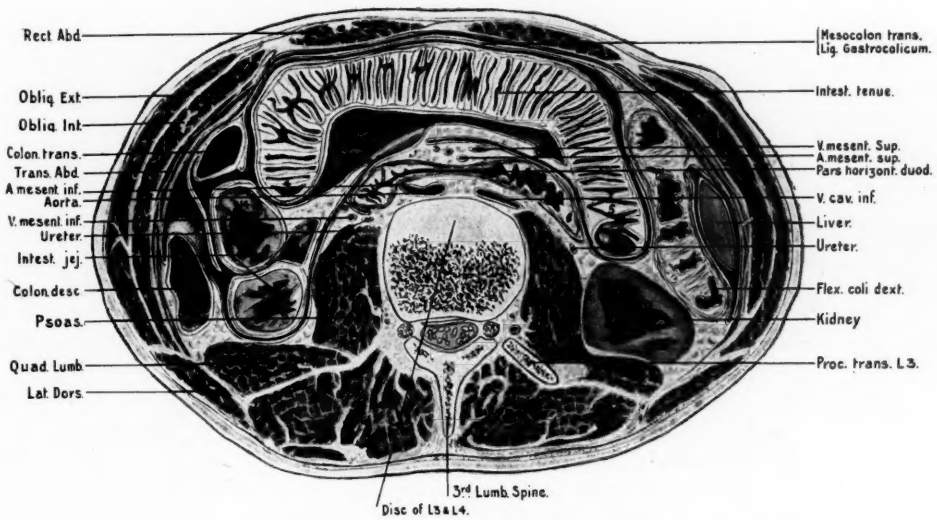

FIG. 167.—Upper surface of *Slab XIV* (Man 50), showing the position of the missile in *Case* 729. (× ⅓.)

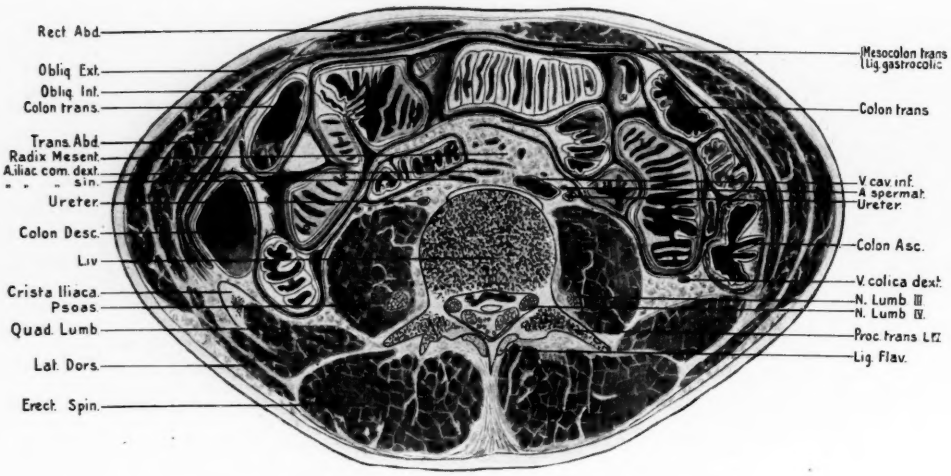

FIG. 168.—Upper surface of *Slab XV* (Man 50). (× ¼.)

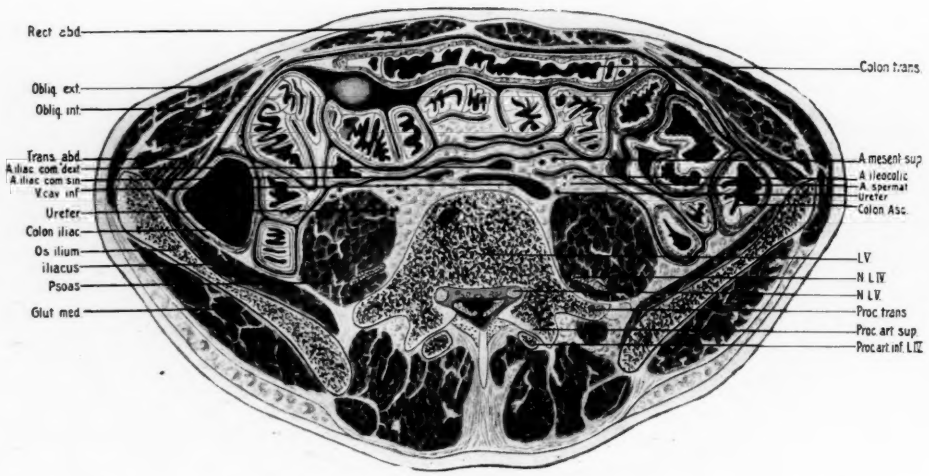

FIG. 169.—Upper surface of *Slab XVI* (Man 50), showing the position of the bullet in *Case* 386. (× ¼.)

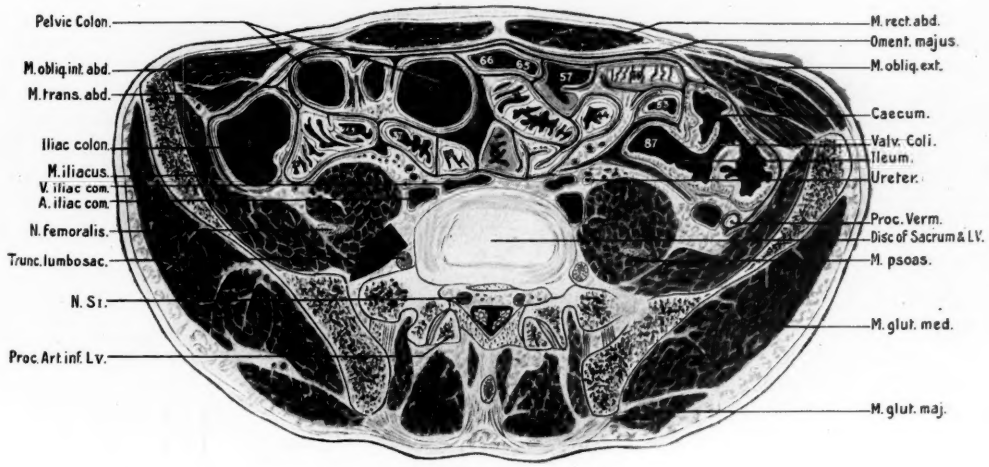

FIG. 170.—Upper surface of *Slab XVII* (Man 50), showing the position of the bullet in *Case* 386. The lumbosacral cord is close to the track. (× ⅓.)

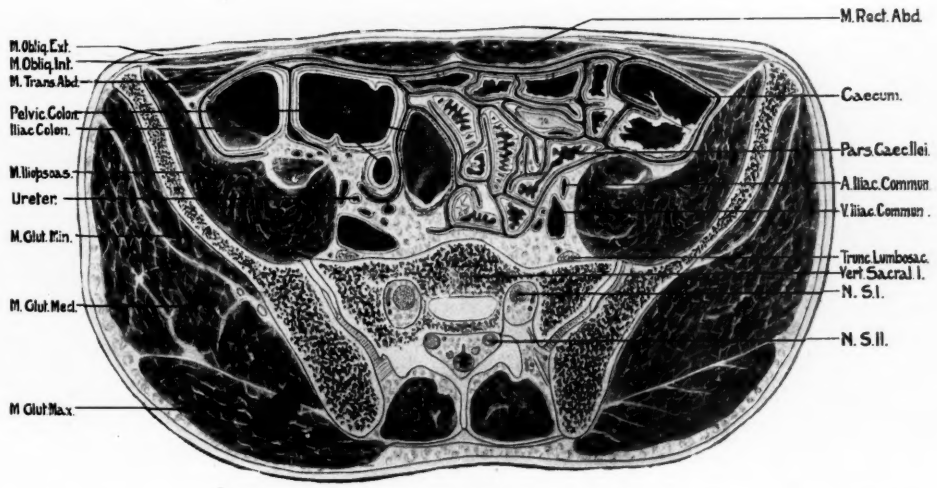

FIG. 171.—Upper surface of *Slab XVIII* (Man 50), showing the position of the bullet in *Case* 386. (× ⅓.)

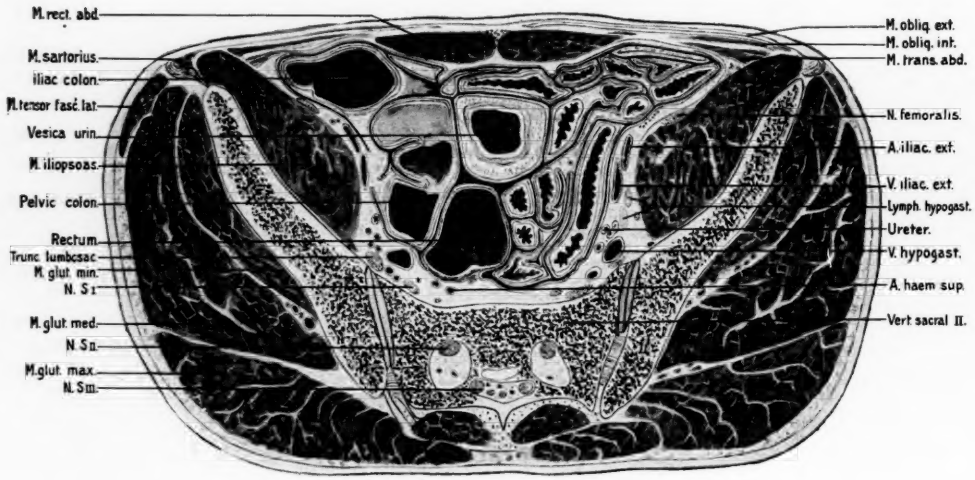

FIG. 172.—Upper surface of *Slab XIX* (Man 50). Note the small intestine lying anterior to the distended bladder. (× $\frac{1}{3}$.)

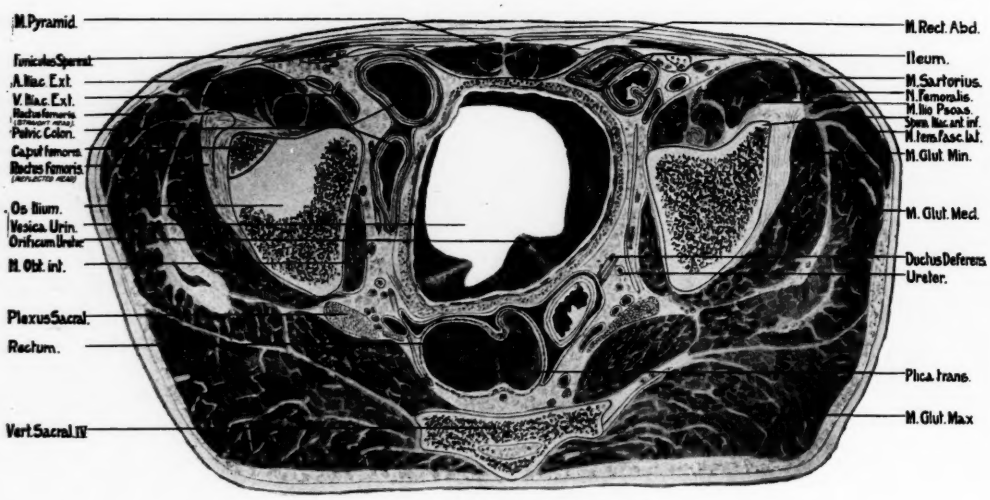

FIG. 173.—Upper surface of *Slab XX* (Man 50). Bladder distended. (× $\frac{1}{3}$.)

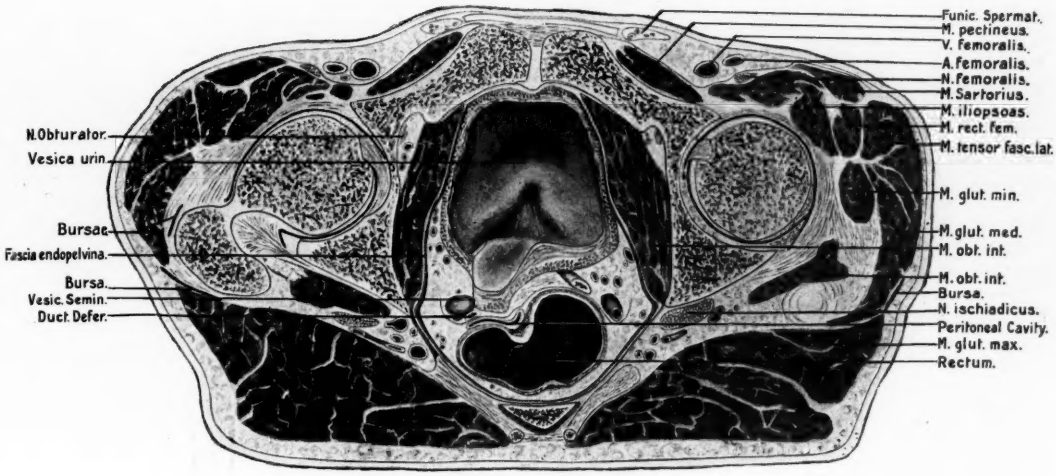

FIG. 174.—Upper surface of *Slab XXI* (Man 50). This section passes through the hip-joint, the rectum, and the base of the bladder (× ½.)

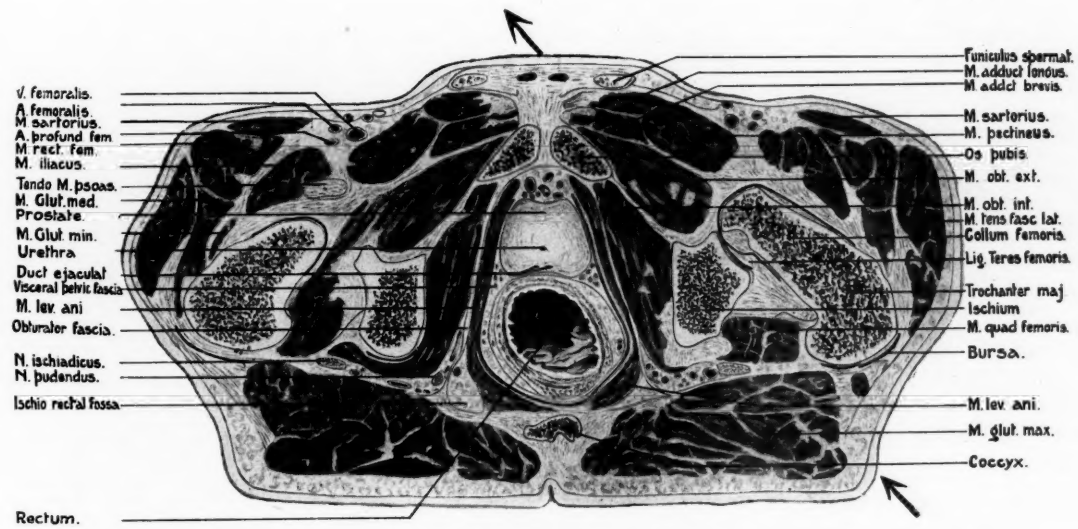

FIG. 175.—Upper surface of *Slab XXII* (Man 50). A straight line connecting the two arrows will give the course of the bullet in *Case* 600, and it also illustrates *Case* 111, where a piece of metal was lodged in the left obturator externus muscle. (× ½.)

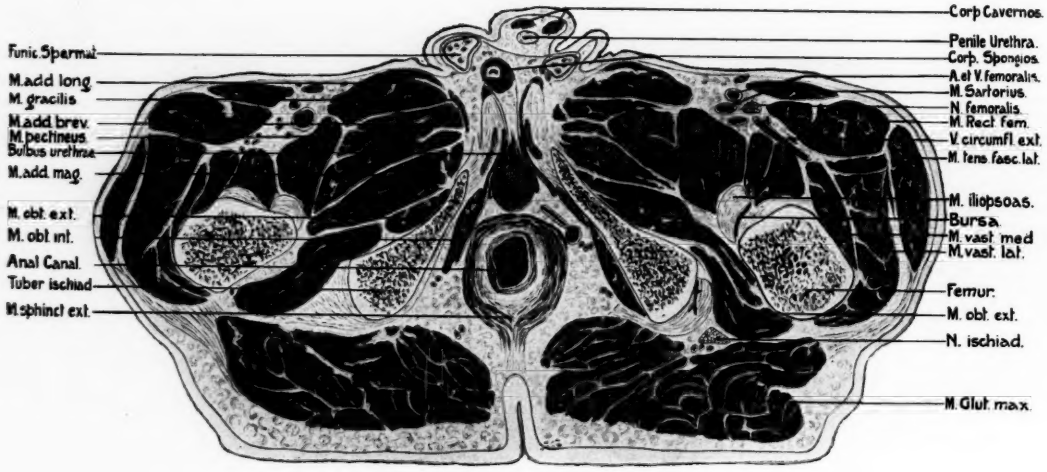

FIG. 176.—Upper surface of *Slab XXIII* (Man 50). (× ⅓.)

In conclusion, I should like to thank Professor Symington for permission to use the brain and reconstructions in *Figs.* 142, 143, 145 and 155, and to thank Messrs. Appleton & Co., the publishers of the *Cross Section Anatomy* (Eycleshymer and Schoemaker), for permission to use the sections illustrated in *Figs.* 149 and 154.

THE TREATMENT OF PAPILLOMA OF THE BLADDER BY THE HIGH-FREQUENCY CURRENT.

By J. W. THOMSON WALKER, London.

The treatment of papilloma of the bladder has been a fruitful subject for discussion among surgeons during the last decade. Two classes of operative procedure have been used, namely, the open method by suprapubic operation, and the intravesical or transurethral method. Each has its advocates, and each has certain advantages and disadvantages.

The transurethral method is carried out by means of an operation cystoscope originally invented by Nitze, or through the open or direct cystoscope of Kelly and Luys. The advantages of removing a papilloma of the bladder through the urethra without an open wound are obvious, and the method is claimed by its advocates to give good late-results. There are, however, very distinct limitations to its use. The instruments are delicate, and their employment demands a considerable degree of mechanical skill. Only those papillomata which are conveniently situated, and are of moderate size and small in numbers, are suitable for treatment by this method. Further, unless the growth is very small, a number of sittings is required, and the treatment covers a considerable period of time. Operation through the open cystoscope of Kelly or Luys, by means of snares, forceps, or a fine electric cautery, has the special disadvantage that there is frequently great difficulty in obtaining a proper distention of the bladder by atmospheric pressure, even when the patient is placed in the full Trendelenburg position.

The open operation has in its favour, that all papillomata can be treated by it, whether small or large, single or multiple, and whatever position they may occupy. It has the disadvantage that it is a more serious undertaking, suitable for large or multiple growths, but too formidable for small papillomata, whether primary or recurrent. It is also true that recurrence of the papilloma is fairly frequent after an operation. Whether it is more frequent, in the same class of cases, than after operation by the transurethral method, is very doubtful. For some years I tried, by painting the interior of the bladder with 4 per cent silver nitrate solution after open operations, to prevent recurrence by destroying invisible papillomata, or implanted fragments, which might be the source of recurrence. This has not, however, been invariably successful, for recurrence has taken place in spite of it.

In 1910, Beer, of New York,[1] introduced an entirely new method of treatment of growths of the bladder by exposure to the high-frequency current. This method has revolutionized the treatment of papilloma of the bladder. The current had been used for some fifteen years for the removal of surface growths, and, as Beer states, the novel feature of his method consisted in

the use of these currents under water, and in the urinary bladder. I shall first describe the method, and then proceed to discuss its application.

Two forms of current are used, namely, the Oudin or unipolar, and the d'Arsonval or bipolar. In the Oudin or unipolar current, which is used by Beer and others, a single electrode is used, and is applied to the growth, the return current passing to earth from the surface of the body. In the d'Arsonval or bipolar current, one electrode is applied to the growth, and the second, by means of a moistened pad, to the surface of the body.

The nomenclature of the procedure has given rise to considerable difficulty, and no one term appears to be generally accepted as accurately describing the method.[2] Fulguration is the method used by De Keating-Hart for surface growths. It differs from Beer's method in that a spark-gap is employed between the terminal and the growth, and 'fulguration' refers definitely to the 'long, lightning-like sparks' produced in the De Keating-Hart method. In Beer's method the electrode is applied directly to the growth in a fluid medium, and no sparks are developed. The term 'fulguration' is therefore misapplied when used for Beer's method. Perhaps the term 'electro-coagulation,' employed by Doyen to describe the effect of the high-frequency current used to destroy growths elsewhere in the body, most nearly describes the process. As d'Arsonval demonstrated in 1896, a high-frequency current will produce a rise of temperature in the tissues between two electrodes, and this was used by Nagelschmidt[3] in 1907, under the name of 'diathermy,' for the destruction of new growths. The bipolar or d'Arsonval current may be used in the Beer treatment of bladder growths, and the term 'diathermy' is correctly applied to this use of the bipolar current. The term 'electro-coagulation' expresses the effect of the high-frequency current either by the unipolar or by the bipolar method, and might well be applied to the whole procedure, the qualification 'unipolar' or 'bipolar' being added, if desired, to indicate the form of current used.

TECHNIQUE.

Beer uses the unipolar current, and the following description is taken from his account of the method: The essential instruments are: (1) A high-frequency machine with Oudin resonator; (2) A catheterizing cystoscope; (3) A heavily insulated copper electrode. The source of the original current may be the main. If this does not alternate, the high-frequency machine must be fitted with an alternator. Beer employs a Nitze double-catheter cystoscope. In one catheter tunnel he places the electrode, and to the other he attaches a tube for irrigation. The application is made directly to the growth, the electrode being pushed a short distance in among the villi. The current is turned on at various points for fifteen to thirty seconds, a total of three to five minutes usually sufficing at one sitting. A few days later it should be repeated, provided any viable tumour tissue is visible. The applications are discontinued as soon as the whole growth appears necrotic. The sloughs are allowed to separate, and the base thus exposed is treated in a similar manner.

I have employed the bipolar current, and will describe more fully the method with which I am familiar. The high-frequency apparatus is contained in a

movable box, two feet square, which is connected with the main electric current. It is necessary that the apparatus should be specially constructed for the current which it is to modify. I have occasion to work in London with three different main currents, namely, a constant current of 240 volts, another of 110 volts, and an alternating current. The apparatus I employ is constructed for use with any of these. To one pole of the apparatus is attached a large flat electrode (6 × 4 inches), and to the other a terminal in the form of a fine copper wire, seventeen inches in length, and insulated in its whole length as far as a terminal platinum bulb which is left exposed. This insulated wire has the suppleness and calibre of a ureteric catheter (No. 5 or 6). The application is made through a catheterizing cystoscope. The procedure is as follows :—

The apparatus is first tested : the high-frequency apparatus is connected with the main current, and the pad-electrode well soaked in saline solution.

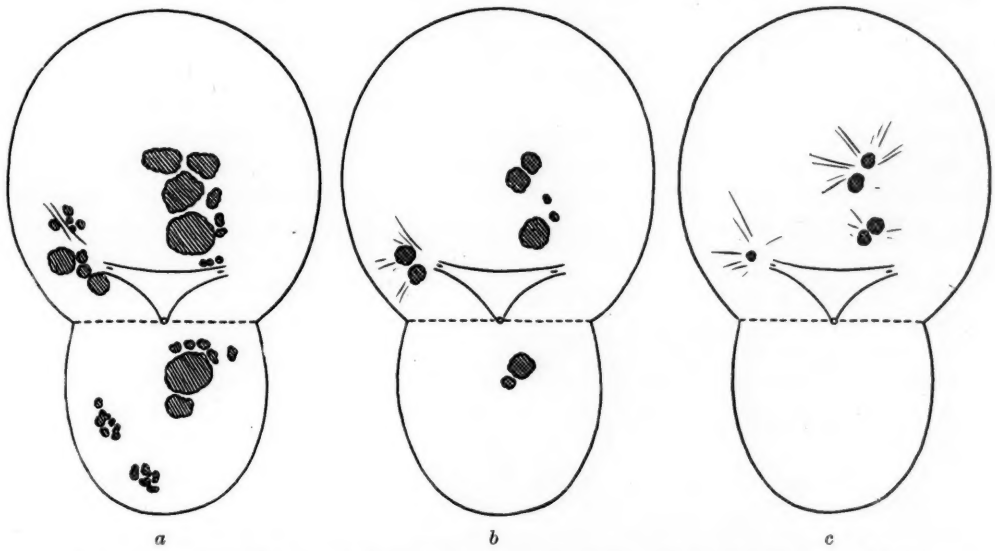

FIG. 177.—Series of charts indicating the positions of growths on the bladder wall at different stages of treatment of a case. *a*, Dec., 1915 ; *b*, April, 1916 ; *c*, May, 1916.

A small piece of raw meat is placed on the pad, and the platinum bulb of the other terminal placed in contact with it. The current is switched on, and very quickly a whitened area appears round the electrode. By shortening the spark in the high-frequency apparatus, the cauterizing effect can be intensified, and this should be adjusted to give the maximum effect. The apparatus is now ready for use. The electrode is placed in antiseptic solution, and the patient is prepared for cystoscopy.

The urethra is thoroughly anæsthetized by injecting a drachm of 4 per cent novocain solution into the anterior urethra, and massaging it back through the compressor muscle. The cystoscope is introduced, and the bladder washed and distended with boracic solution or sterile water. A distention of eight or ten ounces will usually suffice, but more may be required if the growth is in an inaccessible position. Before commencing the treatment, the surgeon

should construct a map, showing the position, character, and size of the growths (*Fig.* 177). This is necessary for checking the results of the treatment. The cautery electrode is introduced along the catheter tunnel, and the platinum bulb is made to approach the growth, under the eye of the operator. The pad is now applied to the patient, being placed in the suprapubic region, or under the sacrum, or on the thigh. When the growth is situated on the anterior wall, or at the apex, I apply the pad suprapubically; when at the base or on the posterior wall, the pad is placed over the sacrum; and when situated on the lateral wall, the pad is folded over the upper part of the corresponding thigh, the object of these varieties being to facilitate the passage of the current from the periphery to the centre and base of the tumour (*Fig.* 178).

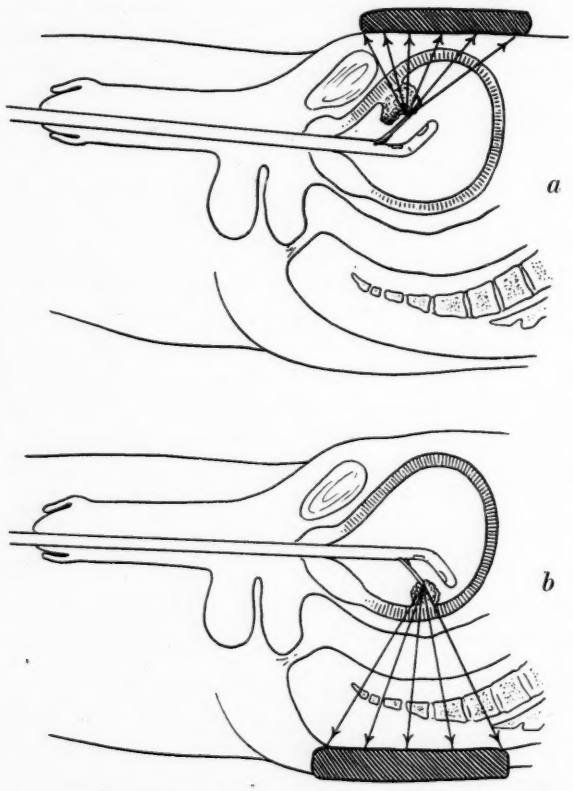

FIG. 178.—To illustrate the application of the pad-electrode in growths on (*a*) the anterior and (*b*) the posterior wall of the bladder.

As the current flows, certain phenomena appear in relation to the terminal, which has been buried in the growth. At first a swirl of fluid and a movement of fine villi are seen, and then, after the current has been running for some seconds, bubbles of gas shoot out alongside the electrode. Occasionally, where the action of the current is very energetic, and the application prolonged, a miniature explosion occurs, and may be repeated, shaking the villi of the tumour. Some oozing of blood not uncommonly appears, and if the growth is on the anterior wall, a fine thread-like stream of blood may fall towards and past the window of the cystoscope. Visible changes occur in the growth itself. Around the electrode a pale-coloured halo appears, and this becomes opaque white.

When the electrode is withdrawn, the tumour may be adherent to it, and the whole tumour is drawn up towards the window of the cystoscope till the drag is too strong, when it falls back, showing a round dark hole surrounded by an opaque white area of necrosis (*Fig.* 179), which, compared with the rest of the growth, is firm and inelastic. Occasionally the electrode point comes in contact with the stem of a considerable branch of growth. The surface of this area changes in appearance. The tip of each fine pink villus becomes swollen and tense, almost cyst-like in appearance, and darker in colour;

and the group of villi thus changed has the appearance of a bunch of very tiny grapes.

When the electrode is withdrawn, white, shreddy masses of necrotic, asbestos-like material adhere to it. Occasionally a branch of the papilloma of considerable size comes away on the point of the electrode.

Applications of twenty to thirty seconds may be made at first, and repeated a number of times. Later on, the current may be passed continuously for several minutes (three to six) without complaint from the patient. The longest continuous application that I have made is six minutes, and the greatest duration of current flow at one sitting, comprising a number of applications, is thirteen minutes twelve seconds. Apart from nervousness on the part of the patient, the bladder may, during a prolonged sitting, become irritable and spasmodic. This may be due to the temperature of the distending fluid being raised by the electric discharge, and is overcome by emptying and refilling the bladder.

The prolonged contact of the cystoscope with the urethral wall, and the effect of the local anæsthetic passing off, together with the movements of the cystoscope and electrode within the bladder, may stimulate the bladder to repeated contraction, which becomes at length uncontrollable. The levatores ani appear to take a prominent part in the spasm, for the whole base of the bladder, together with the prostate, is raised up spasmodically from time to time. Cloudiness of the fluid from admixture of débris and blood necessitates washing of the bladder.

When a small papilloma is being treated, the platinum terminal is sunk into its centre, and very quickly the whole of the growth is seen to whiten, and shreds of it, or the entire growth, come away on the point of the electrode.

In dealing with a larger mass of papilloma, an attempt should be made to treat segments of it at a time. A fortunate application may destroy the main branch of a large segment of the tumour. This may not, however, be possible, and the electrode is sunk among the villi, taking care that it is not deflected or pushed too far and thus brought into contact with the mucous membrane.

Sometimes, by sweeping the electrode beneath the papilloma, a pedicle may be found, and if contact with this can be maintained, the growth will be destroyed more quickly than if it were attacked in segments. In attempting this, however, the bladder mucous membrane may be cauterized, giving rise to severe pain.

I have several times attempted, by cauterizing the large blood-vessels passing into the base of the growth, to cut off the blood-supply, and thus strangle the growth. This has not, however, been successful in destroying the growth without further direct applications to the tumour mass. The blood-supply of these growths, although in large part derived from superficial vessels clearly visible on the surrounding mucous membrane, is partly obtained from vessels passing directly to them from the submucous blood-vessels.

Where multiple growths are present, it will be found convenient to destroy these situated at and around the internal meatus, before proceeding to deal with those in more remote parts of the bladder.

Papillomatous growths are insensitive, and the passing of the current does not cause any pain. If, however, the electrode should happen to touch the

bladder mucous membrane, a sharp pain like the sting of a wasp is experienced, and will continue until the electrode is removed from contact with the mucous membrane. Occasionally the electrode may be pushed through a luxuriant growth and inadvertently touch the mucous membrane at its base, when pain is at once experienced. When the growth lies at the lip of the internal meatus, it is difficult to avoid contact of the cautery with the mucous membrane, more sensitive at this spot than at any other part of the urinary tract. As a result, treatment of papillomata in this situation is usually painful.

After a time the fluid medium in the bladder becomes cloudy with débris and blood, and the bladder should be washed out before further applications are made. The sitting may eventually have to be suspended on this account. At the end of each sitting the bladder should be thoroughly irrigated with weak silver nitrate solution (1–10,000).

Where the papillomata are luxuriant and friable, I have found the instillation of nitrate of silver solution at the end of each sitting of great assistance. Half a drachm of two per cent or four per cent solution of nitrate of silver is instilled by means of a Guyon's syringe, and left in the bladder. This is

DESCRIPTION OF PLATE.

FIG. 179.—A papilloma after withdrawal of the electrode, showing necrotic tissue at the site of application and adhering to the electrode.

FIG. 180.—Partly-destroyed papilloma and oval ulcer with adherent slough and surrounding inflammation.

FIG. 181.—Ulcer after destruction of papilloma, showing oval shape and surrounding rampart of swollen mucous membrane.

FIG. 182.—Pitting of bladder wall after healing of ulcer (below and to right); ulcer from recent cauterization, with adherent slough and raised edges (above and to left); small ulcer with surrounding œdema (to right).

FIG. 183.—Trabeculation and sacculation occasionally observed some months after high-frequency treatment.

especially helpful where friable masses of growth crowd thickly around the bladder outlet. In this position, removal by means of the cautery alone is difficult, and repeated applications are necessary. The mucous membrane here is intensely sensitive, and the manipulation of the cystoscope and the heat of the cautery cause considerable pain, which is frequently accompanied by spasm of the bladder and heaving up of the prostate and bladder base by contraction of the levatores ani muscles. The destruction of these growths is brought about partly by the electric cautery and partly by the action of the silver nitrate solution.

A little hæmorrhage may follow this operation, but usually the urine rapidly becomes quite clear. Hæmorrhage is not infrequent ten days or a fortnight after the treatment, and then results from a slough of necrosed growth becoming detached. This hæmorrhage has seldom, in my experience, been alarming, and has been severe in three cases only; and beyond keeping the patient in bed for a day or two, no treatment is usually necessary. Should the hæmorrhage persist, irrigation of the bladder with very weak silver nitrate solution (1–10,000) will speedily check it.

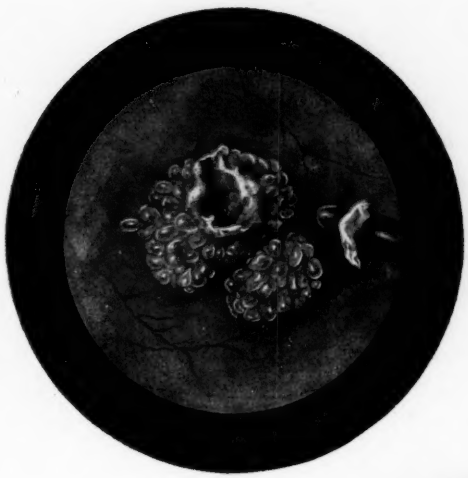

FIG. 179.

FIG. 180.

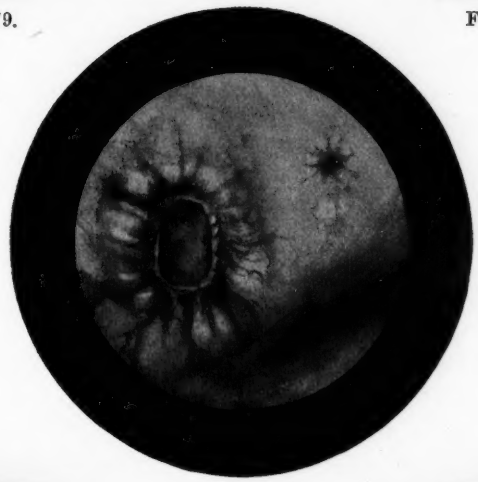

FIG. 181.

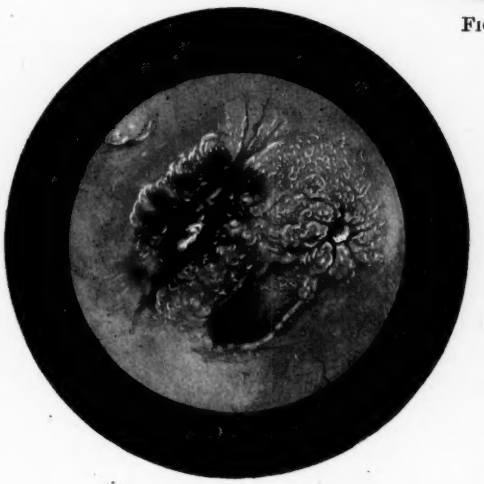

FIG. 182.

FIG. 183.

The duration of an application of the high-frequency current will vary according to a number of factors. For very small growths, a few seconds will suffice; for large or multiple growths, the séance is prolonged, and a number of treatments is necessary. When this is the case, the longest possible application, and the maximum amount of treatment, should be employed at each sitting.

The type of individual has an influence on the duration of the application, and on the ease with which it is made. A placid patient renders invaluable assistance by remaining quiet, while a nervous, irritable subject increases the difficulties by restlessness and complaints. At first, the average patient may be apprehensive and hypersensitive, and short sittings are necessary; but as he gains confidence, more prolonged applications may be made. By care in avoiding contact with the bladder mucous membrane, there need be nothing more than discomfort caused by the presence of the cystoscope in the urethra.

After the destruction of a papilloma, a small area of ulceration is found, covered by an adherent slough (*Figs.* 180 and 181). The appearance is peculiar. A grey slough occupies the centre, in the position of the base of the growth. Around this is a raised rampart of bright red, velvety mucous membrane, with radiating folds and streaks of brighter scarlet. This falls to the surrounding level, and the colour fades at the periphery. This condition is seen a week, or as long as ten days, after the treatment. After this the slough separates, and a granulating surface is left. The raised rampart gradually disappears, and the colour fades. Three weeks after the treatment traces of the ulceration still remain; after that they rapidly disappear, and only a faint scar is left, and even this may disappear.

When repeated applications of the cautery have been necessary, small pits may remain in the bladder wall (*Fig.* 182) after the ulceration has completely healed. In three of my cases an area of about the size of a shilling showed prominent trabeculation, with deep intervening saccules, when the bladder was examined several months after the treatment (*Fig.* 183). In none of these cases was there any trabeculation present at the time of the operation, and there was no urethral obstruction. Two of the patients were females. This condition was undoubtedly due to a local atrophy of the muscular layer of the bladder wall, resulting from the application of the high-frequency current. Whether this will be found to occur in many cases after the application of the high-frequency current to the bladder, one cannot say. It is sufficient here to note that the condition has been observed.

In a few cases the patient has complained of abdominal pain for some days, or even weeks, after the application of the high-frequency current. This pain is not referred to the bladder, but to some area over the lower abdomen, not directly over that viscus. It is unconnected with micturition, or with distention of the bladder, and is unaffected by the condition of the bowel. It is possible that these pains may be due to the action of the current on sensory nerves.

The length of interval between each treatment will vary in different cases. At least a week should elapse, so that sloughs may be given time to become

detached. Where the growth has been cauterized down to the mucous membrane, a fortnight or three weeks' interval should be allowed before re-examining, so that the reaction which occurs in the mucous membrane may be given time to settle down, and the heaped-up edge of the ulcer may not be mistaken for a papilloma, or a small fragment of papilloma be hidden between the thickened folds.

The number of treatments necessary will vary with the size and number of the growths, the tolerance of the patient, and the smooth running of the electrical apparatus. In my cases the average number of applications was four, and the average time during which the current was passed in each case was twelve minutes.

Microscopical Changes occurring in the Growth.—In a case where I proposed to operate by the open method for a suspicious smooth growth, I took the opportunity of treating a clump of papillomas with the high-frequency current a few days before the operation, and thus obtained a specimen for microscopical examination.

The papilloma so treated showed the following features: A large part of the growth was quite unchanged, and differed in no way from the usual appearances presented by a simple papilloma. One part of the tumour showed changes of two types. In the first, the epithelial covering of the villi was unchanged, but the blood-vessels were involved; while in the second type the changes affected the vessels and epithelium of the villus.

FIG. 184.—Microscopical section through a papilloma, showing engorgement of the blood-vessels of the villi on the right, and necrosis of epithelium on the left.

In the first type (*Fig.* 184), the epithelial covering was intact, but the thin-walled blood-vessels of the core were engorged with blood, and dilated to several times their usual size. Tracing the villus back, it was found that towards the base the engorgement of the vessels disappeared, and the vessels might even be collapsed. In a more pronounced degree of this type there was, in addition to the engorgement, effusion of blood into the areolar tissue of the villus, so that the whole core became infiltrated with blood-corpuscles, embedded in which the dilated thin-walled vessels could be distinguished.

In the second type the change in the vessels resembled the preceding type, but there was, in addition, a loss of staining power of the transitional

epithelium covering the villus. The staining of the nuclei was dull, and the nuclear outline and that of the cell were indefinite. The epithelium still retained its structural form. A more advanced change showed destruction of the villus, which was transformed into a mass the elements of which were difficult to recognize. Careful examination showed very numerous capillary blood-vessels embedded in a mass of cells consisting of blood-corpuscles and isolated cells of the epithelium which had almost, or completely, lost their staining properties.

It seems probable that in the first type, in which the blood-vessels only were involved, the changes were brought about indirectly by coagulation of the blood and obstruction of the capillary vessels of the villi. The second type, where changes affected the epithelial structure and led to complete destruction of the villus, was probably the result of the direct cauterizing effect of the high-frequency current.

DIFFICULTIES.

It is a confession of inexperience to suggest, as some writers have, that the method is always simple and without difficulties. In the majority of cases the practised cystoscopist will carry out the treatment with ease; but there are cases where serious, and even insurmountable, obstacles are encountered.

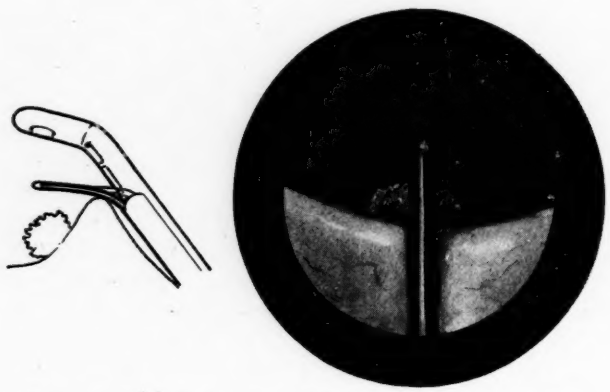

FIG. 185.—To illustrate a papilloma lying below a fold in the bladder wall.

Difficulties are related to the growth, the condition of the bladder, the urethra, and to the build and temperament of the patient.

The position of the growth is an important factor. A papilloma lying in the region of the trigone, in the neighbourhood of the ureteric orifice, or low down on the posterior wall, is in an ideal position for treatment by this method. Certain positions are, however, inconvenient for the application of the electrode. An area at the apex of the bladder is sometimes difficult to get at, and it is necessary to pay out a considerable length of the insulated wire before a growth in this region is reached; the long flexible wire is less under control than a short length, and the application is consequently less accurate. A small papilloma lying behind a fold is difficult of access (*Fig.* 185); such a fold may result from a previous cystotomy, and thus lies near the apex. I have known a trabecula in an obstructed bladder cause some difficulty; and a high interureteric bar may partly conceal a small papilloma, and intervene between it and the electrode.

The least accessible position is on the lip of the internal meatus, or in the immediate neighbourhood of this orifice. Here the cystoscope must be withdrawn until the window lies just within the bladder, and the opening of the catheter tunnel lies in the prostatic urethra. The electrode is prevented by the lip of the internal meatus from coming into contact with the papilloma, and cannot be made to curve round sufficiently to touch it. A mass of papillomata spreading from the internal meatus into the bladder presents similar difficulties (*Fig.* 186). Patient and gentle manipulation may succeed in overcoming these obstacles. An open Luys cystoscope tube, or a posterior urethroscope, may be tried in such cases, and may be successful where the indirect cystoscope has failed.

Growths lying far out from the urethra, and low down towards the front of the lateral wall, are also difficult to reach in the male; in the female subject the broad pelvis and short urethra permit an easier approach to growths in this situation.

The bladder must permit of adequate distention and free intravesical manipulation.

The combination of cystitis with papilloma of the bladder makes the operation very difficult. The bladder holds an inadequate amount of fluid, and is hypersensitive and spasmodic, and the folds of swollen mucous membrane may conceal small papillomata, and make it difficult to estimate the progress made in cauterizing those growths that are visible. Every endeavour should be made to get rid of the cystitis before commencing the high-frequency treatment, and this is usually successful where the growth is small and benign. Where multiple papillomata are present, and in the cases where a luxuriant friable growth covers a large area of mucous membrane, it will be impossible to treat the cystitis with success. Such cases are on this account unsuitable for treatment by the high-frequency current.

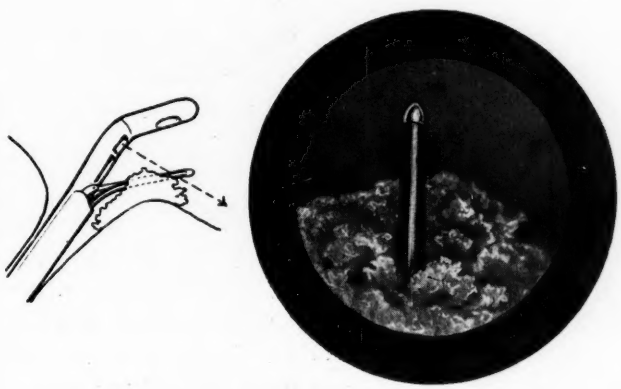

FIG. 186.—To show the difficulty in treating papillomata extending from the internal meatus.

Apart from cystitis, the bladder, in a few cases, is intolerant of prolonged intravesical manipulation; this is more often found in the male than in the female subject, and usually where considerable strain must be placed on the prostatic urethra by the rigid cystoscope in reaching a growth in a difficult position. Patience, gentleness, and efficient local anæsthesia will usually overcome this difficulty.

Enlargement of the prostate, with a prominent rim or lobes projecting into the bladder, may interfere seriously with the necessary manipulation,

especially where the papilloma is at the bladder base, and protected by the rampart of prostatic tissue (*Fig.* 187). The age at which enlargement of the prostate commences, and that at which papilloma develops, are not usually the same, but the combination will be met with occasionally. Chronic prostatitis, with fibrosis of the gland and bladder neck, render the prostatic urethra rigid, and interfere in some degree with the freedom of movement of the cystoscope.

The urethra must not be over-sensitive. The female urethra, with its short, straight course, allows a greater degree of freedom, and the roomy pelvis a wider excursion of the cystoscope, than in the male.

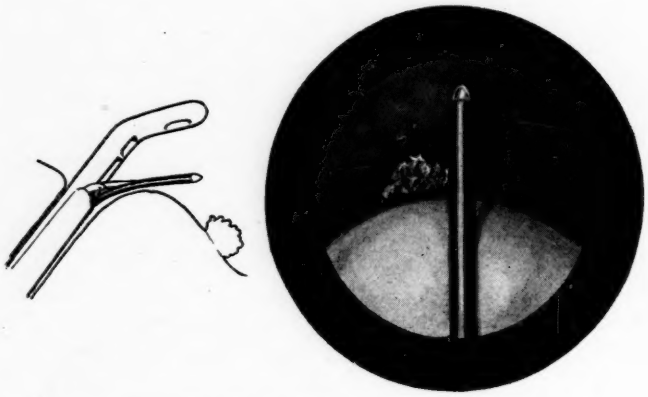

FIG. 187.—Papilloma protected by a bar formed by an enlarged prostate.

The build and temperament of the patient are important. A stout heavy subject is much less suitable for the method than one of slight build. The limits which nervousness and irritability of the patient place upon the use of this method have already been discussed.

CASES SUITABLE AND UNSUITABLE FOR TREATMENT.

The ideal case for treatment by this method is a papilloma of moderate size situated at the base or posterior wall of the bladder, not too near the urethral orifice. Discrete multiple papillomata are easily treated. With the early diagnosis that results from cystoscopy, such cases come under observation very frequently, and a suprapubic operation is unnecessary.

In the early stage of recurrence after open operation, when the papillomatous buds are quite small, the high-frequency method is invaluable. The small papillomata, frequently multiple, are as yet too insignificant, and have caused too little in the way of symptoms, to justify a second operation. The adoption of some method of transurethral operation is imperative, and the high-frequency method is the simplest, and at the same time is completely efficient.

It cannot be said that all forms of growth of the bladder, or even that all cases of simple papilloma of the bladder, are suitable for treatment by this method. Certain multiple coalescing papillomatous growths are better treated by excision, by the suprapubic method. This is principally because open operation is the simpler and quicker method of treating such widespread growths. The prolonged application, and the large number of treatments necessary, make the high-frequency treatment of such cases impossible unless the surgeon has unlimited leisure, and the patient unbounded patience. With this happy

combination there is no objection to the use of the method. For the same reason a very large papilloma, such as one sometimes meets with, is unsuitable for this method. But here, in addition, the difficulties of manipulation in the bladder are great, and it may be quite impossible, either from recurrent hæmorrhage, or from the great quantity of papillomatous material hoodwinking the cystoscope, to see the growth clearly in order to apply the electrode.

Again, septic growths are unsuitable for high-frequency treatment. Apart from the fact to which I have already referred, that the bladder is hypersensitive and spasmodic, the treatment tends to increase the irritability of the organ, and sloughs of papillomatous material destroyed by the current add fresh soil for the development of bacteria, and increase the cystitis. When the growth is small, there is a good prospect that treatment will cure the cystitis, and the high-frequency method can then be employed. Where, however, the growths are multiple and extensive, the cystitis will persist in spite of treatment, and the shortest and most practical method is to open the bladder suprapubically, clear out the growths, and by means of free drainage and continuous irrigation effectively treat the cystitis. At regular intervals after the operation the bladder is inspected carefully, and any recurrence is at once treated with the high-frequency current.

Some growths in the immediate neighbourhood of the urethral orifice are unsuitable for this treatment. Small growths, even when the mechanical difficulty of getting down to them with the cautery is great, are practically always open to attack ; but in large growths spreading into the prostatic urethra and around the meatus, it is hardly worth while attempting ; the more so that in these cases there are usually multiple growths in the bladder, possibly of considerable size.

It is generally agreed that malignant growths are unsuitable for treatment by this method. Although the high-frequency current causes destruction of tissue on the surface, this is very rapidly replaced, and it is stated that the effect on a malignant growth, apart from the localized necrotic effect, is to stimulate the activity of the undestroyed cancer cells.

I have not treated malignant growths by the high-frequency method, for the reason that I hold that if the growth is of suitable size for radical treatment, the most thorough method of resection of the bladder walls is the proper procedure ; and, moreover, the true extent of the growth—that is, its intramural and extravesical extent—cannot be gauged by the cystoscope, and will not be known until the bladder is opened, and the growth examined by touch from within and outside the bladder wall.

The treatment of hæmorrhage in a malignant growth by this method should not be confused with the treatment which has a cure for its object. This symptomatic treatment has been used, and is advocated by some observers. I have not met with a case where it appeared to me to have any advantages. If the hæmorrhage is really severe, this method will be impossible, and the most effective and logical treatment is to open the bladder, and remove as much of the growth as possible by scraping. If the hæmorrhage is slight, it can be treated by washing the bladder.

The really difficult cases are those when a justifiable doubt arises in regard

No.	Name and Sex	Age	Primary or Recurrent	Previous Operations		Growth Single or Multiple	Character of Growth	Position of Growth	Bladder	Urethra and Prostate	Type Patie
				No. and Character	Date						
1	Mrs. O.	64	R.	1 Avulsion with forceps	8 weeks previously	Single	Size of large pea	Behind left ureteric orifice	Healthy	Urethra normal	Plac
2	Mrs. B.	58	P.	—	—	Single	Large soft papilloma, size of walnut. Pedunculated	Behind right ureteric orifice	Healthy	Urethra normal	Plac
3	J., male	39	R.	1 Dissection	3 years	Single	Pea size	Behind left ureteric orifice	Healthy	Normal	Plac
4	B., male	47	P.	—	—	Single	Large pea size, feathery	Behind left ureteric orifice	Healthy	Prostate enlarged, projects as rim into bladder	Nervo
5	Mrs. S.	36	R.	3 Old type	Last operation 6 months ago	Single	Large pea size	Outside right ureter	Healthy	Urethra normal	Nervo
6	Mrs. S.	45	P.	—	—	Single	Soft, friable, hazel-nut size	At apex of bladder	Spasmodic, no cystitis	Urethra sensitive	Nervo
7	W., male	56	R.	1	6 months	Multiple	Readily bleeding	Posterior wall, left lateral wall, behind left ureteric and round urethral orifices	Cystitis	Urethra very tender	Sensit
8	W., male	63	P.	—	—	Single	Pea size	Behind left ureter	Healthy	Collar-like enlargement prostate, lo residual uri	Placi
9	H., male	39	R.	2 Thorough	1905 1913	Multiple	Small ordinary type	3 near apex, 1 internal meatus	Healthy	Very sensitive	Nervo
10	W. G., male	54	R.	1	4½ years previously	Multiple 6	6 small ordinary type	On posterior and lateral walls	Normal	Normal	Placi
11	R., male	54	R.	1 Growth wrenched away with forceps	15 years	Multiple 5	Large simple papillomata, and small buds	At internal meatus, round left ureteric orifice, and on posterior wall	Normal	Normal	Placi
12	C., male	30	P.	—	—	Single	Sessile, very dark colour, walnut size	Anterior wall high up; very difficult to reach	Normal	Normal	Very nervo
13	L., male	59	R.	1	4 years	Multiple	Ordinary type	Posterior wall high up	Normal	Normal	Nervo
14	Miss C.	40	R.	1 Thorough	5 months	Single	Small ordinary	Behind right ureter	Healthy		Placi
15	W., male	60	P.	—	—	Multiple grouped	Small, partly sessile	Near right ureteric orifice	Slight cystitis	Prostate enlarged	Placi
16	J. P., male	77	P.	—	—	Multiple	3 small, 1 large	Behind right ureter; anterior lip of meatus	Cystitis; trabeculation	Previous pro tatectomy; urethra rigi	Placi

Type of Patient	Treatment		After-Effects	Recurrence	Remarks
	No. of Sittings	Total Duration			
Placid	1	1 min. 45 secs.	Pain left groin, pricking in scar, no hæmorrhage	None : 10 months	—
Placid	9	34 mins. 55 secs. (Longest continuous, 3 m. 49 s.)	Moderate amount of hæmorrhage	None : 7 months	Attempt to cauterize pedicle failed
Placid	1	1 min. 28 secs.	0	None : 2 years	—
Nervous	1	2 mins. 14 secs.	No hæmorrhage	None : 1 year 6 months	Slight difficulty due to prostate
Nervous	1	1 min.	0	None : 1 year	Considerable amount of pain during application
Nervous	1	2 mins. 19 secs.	Hæmorrhage, immediate	None : 8 months	Very friable growth ; quickly fell to pieces with the cautery
Sensitive	7	6 mins. 17 secs.	—	—	Removed papillomata from all parts except round internal meatus. Had to abandon treatment on account of great sensitiveness of urethra and spasm of bladder
Placid	1	1 min. 5 secs.	0	None : 2 years 1 month	—
Nervous	2	7 mins. 19 secs.	0	None : 7 months	Great difficulty in approaching papilloma at meatus
Placid	3		Hæmorrhage moderate	None : 2 years 2 months	—
Placid	1st period 11 2nd period 9 3rd period 1	5 months 10 months	0	Bladder free 4 months ; recurrence at 6 spots. After 2nd treatment bladder free 5 months ; recurrence. After 3rd treatment bladder still free, 2 months	Recurrence here was rapid, and took the form partly of discrete nodules and partly of carpeting of areas with sessile papilloma
Very nervous	13	49 mins.	Severe hæmorrhage twice	Reduction in size not corresponding to number of applications	Very difficult to reach and patient nervous and complaining. Still under treatment
Nervous	5	22 mins. 41 secs.	Slight hæmorrhage	Bladder free, recurred in 6 weeks	Still under treatment
Placid	1	—	—	None : 3 months	Local atrophy of bladder
Placid	1	—	0	None : 5 months	Difficulty due to enlarged prostate
Placid	1	2 mins. 26 secs.	—	None : 1 year 3 months	Prostatectomy 5 years previously

Continued on next page

No.	Name and Sex	Age	Primary or Recurrent	Previous Operations		Growth Single or Multiple	Character of Growth	Position of Growth	Bladder	Urethra and Prostate
				No. and Character	Date					
17	Dr. C.	50	P.	—	—	Multiple, 5	Ordinary, discrete	Right base, lateral and anterior wall	Irritable	Prostate en larged, ure thra long
18	Miss A. J.	58	P.	—	—	Single	Ordinary, hazel-nut size	Behind left ureter	Healthy	—
19	Dr. H.	56	R.	1 Wrenching with forceps	6 years	Multiple	Ordinary, discrete	Anterior wall, left lateral wall, and behind left ureter	Normal	Normal
20	Miss F.	60	R.	1 Thorough	7 months	Single	Ordinary, hazel-nut size	Behind right ureteric orifice	Healthy	—
21	Mrs. T.	36	R.	1 Thorough	1 year	Multiple	Sessile and discrete subsessile	At internal meatus and on posterior wall	Very sensitive, cystitis	—
22	B. H., male	48	P.	—	—	Single	Ordinary, hazel-nut size	Behind right ureteric orifice	Healthy	Very sensiti
23	K., male	65	R.	1 Thorough. Very extensive multiple growth	7 months	Multiple	Extensive sessile and subsessile	At internal meatus and base	Cystitis	Very sensiti
24	Miss R.	48	R.	2 Very thorough, great masses of papilloma removed	Last 5 months	Multiple	Discrete papillomata, and areas covered with sessile papilloma	Round ureters, on posterior and anterior walls	Slight cystitis, sensitive	—
25	Mrs. C.	65	P.	—	—	Single	Simple, hazel-nut size	Over left ureteric orifice	"Cystic" cystitis	—
26	W. S., male	44	P.	—	—	Multiple	Size of hazel-nut	Behind right and left ureteric orifices	Healthy	Normal
27	Miss T.	35	P.	—	—	Single	Size of large pea	Posterior wall	Healthy	—
28	G. H., male	58	R.	2 Old type	1909 1910	Multiple, large number	Large soft papillomata	Base, posterior wall, anterior wall, round internal meatus	Healthy	Normal, tolerant
29	Miss A. H.	56	R.	1 Thorough	4 months	Multiple	5 small, subsessile, deep red	Anterior wall	Healthy	—
30	H. N. P. male	50	P.	—	—	Single	Small pedunculated; long, loosely arranged villi	Behind right ureteric orifice	Healthy	Normal
31	A. J. T., male	41	R.	2	20 years 18 years	Multiple	Small, short pedicle	Behind left ureteric orifice	Healthy	Normal
32	B. R.	32	P.	—	—	Single	Irregular, elongated, hazel-nut size	Posterior wall	Healthy	Normal
33	Mrs. L.	76	P.	—	—	Single	Subsessile, gooseberry size	Behind right ureteric orifice	Healthy	—

Type of Patient	Treatment		After-Effects	Recurrence	Remarks
	No. of Sittings	Total Duration			
Heavy build, placid	7	—	—	Last treatment recent	Considerable difficulty owing to heavy build and enlarged prostate
Placid	3	7 mins. 53 secs.	—	None : 7 months	Pain in suprapubic region
Nervous	3	8 mins. 44 secs.	0	None : 3 months	—
Very nervous	1	—	Hæmaturia moderate	1 year 5 months	—
Very nervous and restless	4	—	Suprapubic pain	—	Became hysterical, and refused to continue treatment, which had therefore to be abandoned
Nervous	5	—	Hæmorrhage	None	—
Highly nervous, thin	7	15 mins. 25 secs.	Pain, some hæmorrhage	—	Under treatment. Very difficult owing to thick masses round urethra, and sensitive bladder, Instillation of silver nitrate solution after each treatment. Now reduced to a single growth
Stout, placid	5	32 mins. 54 secs.	Severe hæmorrhage twice	—	Still under treatment, number of growths much reduced. During treatment severe pain at right side of bladder base. After treatment, pain in lower abdomen
Stout, placid	2	12 mins.	—	—	Still under treatment
Placid	2	9 mins. 5 secs.	0	—	Under treatment. Tried to cauterize vessels, but without effect
Placid	1	4 mins. 25 secs.	—	None	Destruction rapid
Placid	1	4 mins. 40 secs.	0	—	Under treatment
Nervous	1	—	—	—	Growths easily destroyed at one sitting
Placid	1	—	—	—	Destroyed at one sitting
Placid	1	2 mins.	—	—	Complete destruction at one sitting
Placid	1	4 mins. 50 secs.	—	—	Major part of growth destroyed at one sitting
Nervous	1	—	—	—	Still under treatment

to the nature of the growth. Here, experience in cystoscopy and in operation on these growths is invaluable, and cannot be replaced by any amount of book learning.

RESULTS.

It is now about five years since this method of treating papilloma of the bladder was introduced, and some cases have been free from recurrence for that period of time. The great majority have, however, been treated and remained free for a much less period. The term 'cured' is, I notice, being freely used for cases free from recurrence for no longer than two years. The results of the method are being claimed as better and more lasting than those of suprapubic operation. That this will prove to be so I sincerely hope, but nothing that has been published up to the present time has given proof that this happy result will be attained.

Recurrence after periods of six, eight, or ten years after open operation is not uncommon (in *Case* 31 symptoms of recurrence first appeared sixteen years after operation), and there is nothing to show us that the same may not occur after the high-frequency treatment. We know so little in regard to the causation and recurrence of papilloma of the bladder that it is wiser not to claim too much in regard to cure by this or that method. Recurrence does in fact occasionally take place after complete destruction of papillomata by means of the high-frequency current. In *Case* 11, recurrent papillomata appeared four months after the bladder had been pronounced clear. After a second course of treatment the bladder remained free for five months, and then recurrence took place. In *Case* 13 there was a recurrence six weeks after the growths had been completely destroyed.

In the light of this experience, it is necessary to examine all patients cystoscopically at stated intervals after this method, just as after removal by suprapubic operation. My practice has been to examine in three months, then after an interval of six months, and then once a year.

Recurrence of papilloma of the bladder, whether after operation or electrocauterization, is not now the serious matter it was before the introduction by Beer of the high-frequency method. If the patient is fully impressed by the importance of frequent inspection of the bladder, and submits to it, the recurrent papilloma can be easily destroyed in its early stage.

The 33 cases of papilloma of the bladder in the accompanying table comprise all the cases suitable for treatment by the high-frequency cautery that have come under my care during the last two years (up to May, 1916).

In 14 of these (42·4 per cent) the growth was completely destroyed at one sitting, and the patients were either not confined to bed at all, or rested only for one day. When this is compared with the circumstances of an open operation, where convalescence will necessarily extend over at least four weeks, the great advantage, in suitable cases, of treatment by the high-frequency cautery over open operation will be recognized. In 1 case two sittings, in 3 cases three sittings, and in 1 case four sittings were required for the removal of the growth; in 5 cases there were five or more sittings. The remainder were still under treatment; some of them having only had one or two applications.

In the cases where five or more sittings were required for the removal of the growths, one of the great disadvantages of the method becomes apparent, namely, the time expended in some cases. In these, however, the growths were very extensive, and in two of the most troublesome (*Cases* 23 and 24), open operations of the most thorough kind had been performed very recently, and had failed to prevent rapid recurrence. In one case where the treatment was very prolonged, the growths were small, sessile, and scattered, and the case was not a promising one for open operation, had this method been selected; moreover, the two rapid recurrences after complete removal in this case could not have been dealt with by repeated operations.

The great value of the method in cases of recurrent growth is well illustrated by *Case* 29, where five small papillomatous growths were discovered four months after a complete open operation, and were destroyed completely by the high-frequency cautery at one sitting.

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ON THE USE OF THE OPAQUE URETERAL CATHETER TO LOCALIZE MISSILES IN THE REGION OF THE KIDNEY AND URETER.

By Colonel ANDREW FULLERTON, C.M.G., A.M.S. (T.C.)

It is highly important to be able to say whether a missile which has penetrated the body so as to lie somewhere in the renal region is actually in the kidney or is situated outside that organ. An aseptic missile may perhaps do no harm in the perirenal tissues, but a foreign body in the kidney itself, or near the ureter, ought to be removed. The kidney is liable to vary so much in position, that the ordinary general rules that guide one in localizing a foreign body in a solid organ may fail, and much unnecessary trauma may be inflicted in the search for it.

Hæmaturia may be due to a missile which simply contuses the kidney without entering it, or to a foreign body which lies in the organ, or has passed through it. We have found the depth of muscle between the kidney and the skin over the back to be greater in a soldier on active service than in an ordinary male of average size. This increased volume of muscle, due to hypertrophy from over-use, places the kidney at a greater depth from the surface than usual, and renders of doubtful value the use of cross-sections of an ordinary average body from an anatomical atlas.

Localization by *x* rays has reached a high state of efficiency; but, as the case about to be mentioned shows, it can only give approximate results when a mobile organ like the kidney is under consideration. I have recently been using the opaque ureteral catheter, combined with stereoscopic radiography, to determine the position of a foreign body in the lumbar region relative to the kidney or ureter, with excellent results. The method is not attended with any great difficulty, and can be carried out, if necessary, without a general anæsthetic. A local anæsthetic to the urethra is desirable. The observation is carried out as follows:—

An opaque ureteral catheter is passed into the pelvis of the kidney on the affected side. We know from experience of pyelography that it usually passes into the uppermost calix (see *Fig.* 190). The upper end of the catheter will probably be within three-quarters of an inch to an inch of the upper end of the kidney, as the upper calix is about that distance, as a rule, from the surface of the upper pole. The upper end of the catheter will form in this way a valuable landmark as regards the position of the kidney. Collargol may be injected to verify the assumption that the catheter is actually at the extreme upper limit of the pelvis, but this should not be done until the position of the foreign body relative to the catheter has been accurately ascertained, as the shadow of the collargol might obscure that of the foreign body. Stereoscopic radiographs are taken with the catheter in position, and the anteroposterior

relation of the foreign body to the opaque catheter noted. Captain Gamlin, R.A.M.C., has in several cases worked out these relative positions by Mackenzie Davidson's method, and I am indebted to him for his great care and skill in taking radiographs, and for helping me in every way with these observations.

The following case will illustrate the method better than any description. A soldier was wounded with a rifle bullet while in the erect position, on March 15, 1916. The range of fire was not known, but as the bullet was slightly deformed at its apex, it had probably ricochetted before entering his body. I am indebted to Captain Meyer for the following brief particulars, taken

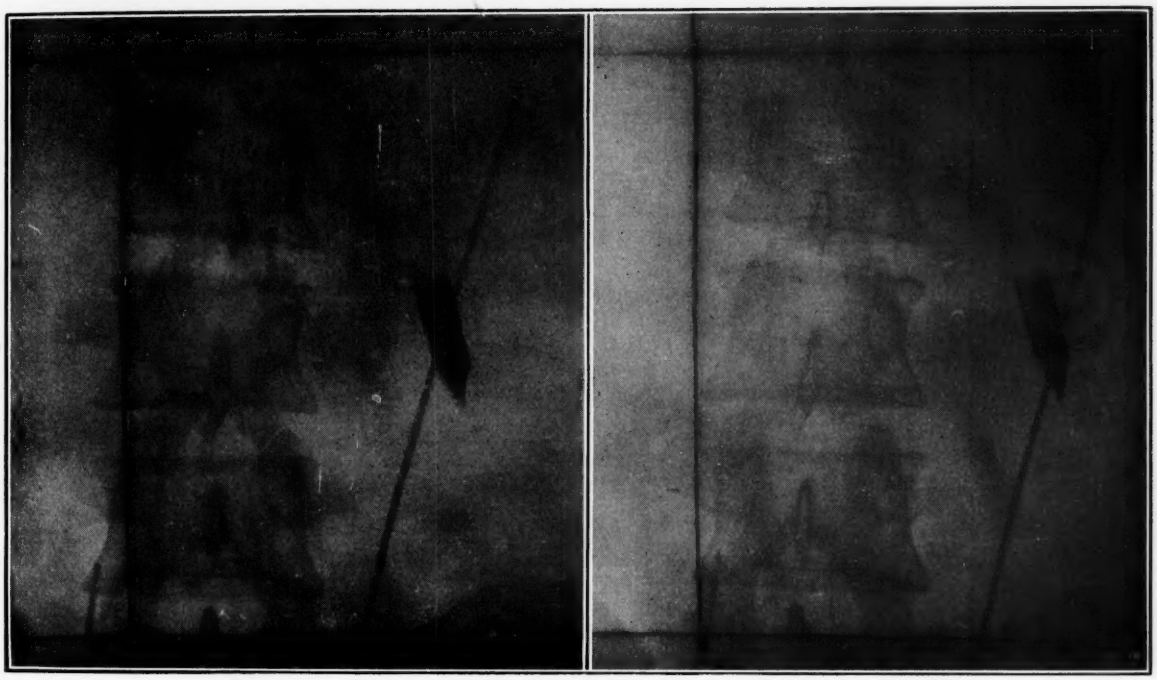

FIG. 188.—Stereoscopic skiagram, showing the position of the missile behind the ureteral catheter.

at a casualty clearing station. The patient was hit in the right side at 7.30 p.m., and was seen by Captain Meyer next day at 5 a.m. After being wounded he had a good deal of difficulty with his breathing. Blood was present in the urine. There was no vomiting. Patient's colour was 'not bad.' Pulse 93. Right side of abdomen rigid as far as umbilicus. Left side normal. Had a 'cold' and a cough before he was wounded. Patient had some fever while at the casualty clearing station, the temperature reaching 104° on one occasion.

When I saw him at a base hospital a few days later, with Major West, the hæmaturia had ceased, having lasted about three days, and his temperature was gradually settling. We found a small punctured wound 11½ cm. above the highest point of the iliac crest on the right side, just behind the

mid-axillary line, 15 cm. from the mid-line of the body, and 5 cm. behind the level of the anterior superior iliac spine. Worked out on cross-sections, the bullet probably passed through the following structures: chest wall, pleural cavity (lower part), diaphragm, peritoneal cavity, liver, kidney.

On March 23 the urine was free from blood, pus, and albumin; sp. gr. 1018; reaction acid. On March 26 stereoscopic radiographs were taken by Captain Gamlin with the opaque catheter in position. At the same time urine was obtained from both ureters, and found to be normal; the sp. gr. was found to be equal on the two sides. Captain Gamlin had previously radiographed the patient, and had come to the conclusion that the bullet was in the right kidney, for two reasons: (1) The bullet moved slightly with respiration; and (2) The depth at which it was located, its distance from the middle line, and

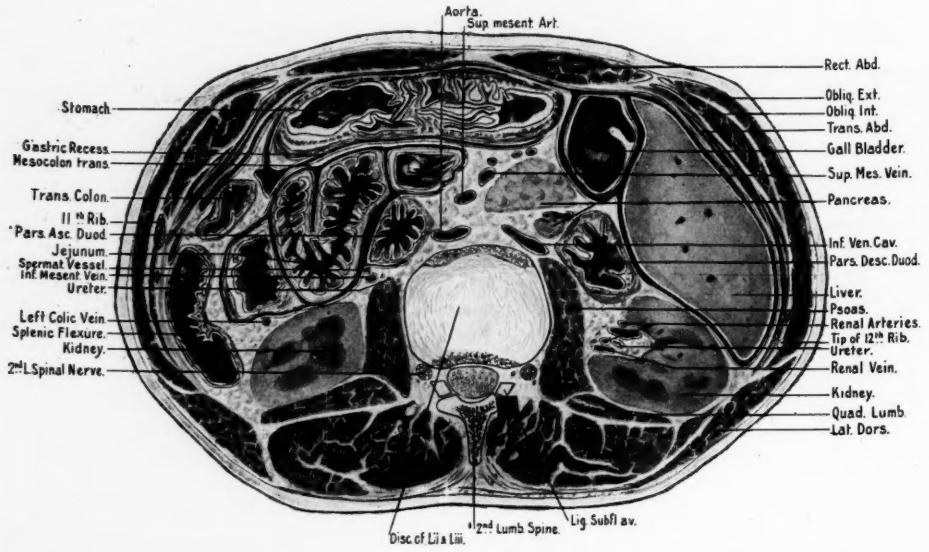

FIG. 189.—Transverse section of a male body at the level of the upper border of the third lumbar vertebra.

its level, corresponded with the position of the normal kidney (see *Figs.* 188 and 189).

The following report was furnished by Captain Gamlin after radiographing with the opaque ureteral catheter in position:—

The distance of the centre of the anode from the plate, which was on the patient's back, was 53 cm., and the shift of the tube was 3 cm. on either side of the central line.

The stereoscopic radiograph (*Fig.* 188) shows that the catheter is in front of the bullet in its whole length.

Measurements of the shadows of bullet and catheter are as follows:—

1. (*a*) The distance of the centre of the base of the bullet from the centre of the spine is 5·6 cm.
   (*b*) The distance of the point of the bullet from the centre of the spine is 6 cm.

2. (*a*) The distance of the centre of the base of the bullet from the plate is 7·6 cm.
   (*b*) The distance of the catheter, on a level with the base of the bullet, from the plate is 9·4 cm.
   Therefore the *base* of the bullet is 1·8 cm. behind the catheter.
   (*c*) The distance of the point of the bullet from the plate is 6·9 cm.
   (*d*) The distance of the catheter, at the level of the point of the bullet, from the plate is 10·5 cm.
   Therefore the *apex* of the bullet is 3·6 cm. behind the catheter.

If reference is made to the radiogram, it will be seen that the base of the bullet is on a line with the upper border of the third lumbar vertebra. If a cross-section of an average male body is taken at this level, and a point is marked on the right side 5·6 cm. from the mid-line and 7·6 cm. from the surface (i.e. from the plate), it will be found to be in the kidney (see *Fig.* 189, immediately above the renal artery). The measurements, however, of the distance of the base and apex of the bullet from the catheter, prove that if the kidney is of normal thickness the bullet must be outside it. We may take it that the catheter is lodged about the central plane of the kidney. The normal kidney is about 3 cm. (nearly 1¼ inches) thick. If the base of the bullet is 1·8 cm. (nearly ¾ inch) behind the catheter, it must therefore be about 3 mm. (⅛ inch) behind the kidney, and the apex further away still. Captain Gamlin estimated the point of the catheter as 2¼ inches (5·7 cm.) distant from the bullet; assuming, then, that the point of the catheter is, say, ¾ to 1 inch from the upper surface of the upper pole of the kidney, the bullet must be from 3 to 3¼ inches from that pole. The kidney is known to be 4½ inches in length; therefore the bullet must be behind the kidney or ureter, at the level of the lower pole. Operation on March 28, by Major West and myself, disclosed the bullet lying in a small abscess cavity just outside the kidney on its posterior surface, at the level of the lower pole (*Fig.* 190), embedded in a large fleshy mass composed of perirenal tissue infiltrated with blood and possibly urine. The bullet had passed through the kidney near the hilum from front to back. The movement on respiration noticed by Captain Gamlin was due to the fact that the large adherent mass of perirenal tissue in which the bullet was lodged moved with the kidney on

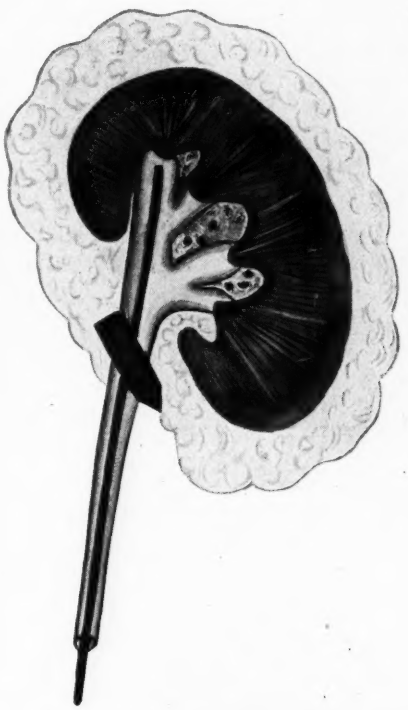

FIG. 190.—Semidiagrammatic section of a kidney showing a catheter passed into the upper calix, and its relation to the bullet. The infiltrated perirenal tissue is shown surrounding the kidney.

respiration. The kidney was pushed forward by this large mass, and thus the fallacy as to the position of the bullet, judged solely from its depth from the surface of the back, was easily explained.

We deemed it advisable to remove the bullet—though we were practically certain that it was well behind the kidney—on account of the patient's temperature, which was no doubt due to the small abscess cavity mentioned above.

In a second case, there were three shadows of shell fragments in the renal region. Two of these were obviously well behind the kidney as seen by stereoscopic radiographs with the opaque catheter in position. The third was located, by the method just described, as lying at the inner margin of the upper pole of the kidney in the position of the suprarenal capsule. Post-mortem examination showed the fragment lying between the upper pole of the kidney and the suprarenal capsule. The missile had grooved the posterior surface of the kidney, and come to rest in the position indicated. I have full notes of this case, for which I am indebted to Captain Fitzmaurice Kelly, and there are other features in connection with it which I hope to refer to in a later communication on injuries to the kidneys. It is mentioned here incidentally as an illustration of a method of localization which I suggest may be of value in certain circumstances.

I am indebted to Miss Rea, of the Anatomical Department of Queen's University, Belfast, for the drawing of the kidney illustrating the position of the bullet relative to the ureteral catheter.

THE INTERPELVI-ABDOMINAL AMPUTATION.

WITH NOTES ON TWO CASES.

By J. HOGARTH PRINGLE, Glasgow.

In the *Lancet* of Feb. 20, 1909, I published a short paper on the interpelvi-abdominal amputation, in which I recorded the histories of three patients for whom I had carried out the operation, and gave a list of the cases I had been able to find up to that time. These numbered 21 in all; 18 being cases of sarcoma, and 3 of tuberculous disease of the hip-bone. My own experience concerned two patients with widespread tuberculous disease, and one with sarcoma; and I may here give brief abstracts of these cases.

Case 1.—A girl, age 10, was first seen in November, 1899, suffering from tuberculous disease of the left hip-joint. The joint was excised, and the wound became tuberculous. About the end of February, 1900, a large abscess formed in the iliac fossa. On March 5 exarticulation at the hip-joint, with removal of the acetabulum and a considerable part of the ilium, was done, a large fœtid abscess being opened into. On June 1 the left os coxæ was removed. The patient lived for fourteen years afterwards, and died of some cerebral condition the nature of which is not known to me: possibly it was tuberculous in origin.

Case 2.—Adult male, admitted in May, 1902, with abscess over left Poupart's ligament, which was opened and healed well. Re-admitted in 1904 with a large left gluteal abscess, which healed well after incision. Re-admitted in 1906 with the left hip-joint flexed and fixed at a right angle; there were sinuses at the sites of the former incisions, and the patient was very emaciated. In May, 1906, exarticulation at the left hip-joint; the acetabulum was bored through and a large intrapelvic abscess opened, and a large part of the ilium was removed above and behind the acetabulum for free drainage. The wound never healed, and in October, 1906, the left os coxæ was removed. Death took place from shock about fourteen hours later.

Case 3.—Male, age 18, first seen in November, 1906, with a sarcoma of the lower extremity of the left femur. The limb was amputated below the trochanters. In February, 1908, there was a small tumour at the origins of the left hamstring muscles, and on Feb. 12 the interpelvi-abdominal amputation was carried out. Death occurred on July 3, with metastases in various parts of the body.

Of the 19 cases of sarcoma known up to that date, only 6 patients survived the shock of the operation, and 13 died, a mortality of 68·4 per cent. Of the 5 cases of tuberculous disease, 2 recovered—a patient of Bardenheuer and one of my own.

Since my former paper there have been 17 additional instances of the operation recorded: 9 for neoplasms, 7 for tubercle, and 1 for acute osteomyelitis. Last year 2 patients were operated upon successfully by me; and it may be worth while to review the subject again.

The indications for the operation are :—

1. Neoplasms arising from (*a*) The hip-bone ; (*b*) The femur so high up that the disease cannot be removed by an exarticulation at the hip-joint ; (*c*) Muscles or fasciæ in the region of the hip.

2. Infective processes involving the hip-bone : (*a*) Tuberculous disease ; (*b*) Acute osteomyelitis ; (*c*) Actinomycosis might possibly justify the operation in some rare instances.

In the majority of the cases the operation has been carried out in one stage—namely, removal of the limb along with the hip-bone ; but in a few it has been done in two stages—exarticulation at the hip-joint, followed by the removal of the hip-bone at a later date. This point is of some importance with regard to the cases of infective disease which may require the operation ; and the factors which, in my opinion, should determine which of these procedures is the correct one to follow in the case of tuberculous disease are (1) The extent of the disease ; and (2) The state of the patient at the time of operation.

In my own experience of advanced tuberculous disease of the pelvis with intrapelvic suppuration, I have found that exarticulation at the hip-joint along with removal of the acetabulum and the adjacent part of the iliac bone has sometimes given very satisfactory results. This had been carried out in my two patients for whom it eventually became necessary to remove the hip-bone ; and although in itself it is an operation of considerable severity, it is decidedly less severe than a primary interpelvi-abdominal amputation in one sitting.

An important fact to be kept in mind is that, after the interpelvi-abdominal amputation, any support for an artificial limb is removed ; only a soft elastic surface is left, as yielding as the anterior abdominal wall of any ordinary individual ; so that on this account every endeavour should be made to preserve the hip-bone. In *Case* 1, where the patient survived her operation, a very large re-formation of bone took place in the stump ; to outward appearances it closely resembled one after an exarticulation at the hip, and she could have worn an artificial limb as well as any patient can after that operation, but I never felt justified in advising her to go to the expense of getting one. Axhausen, in the hope of giving a support for an artificial limb, grafted a piece of the patient's tibia between the sawn ends of the bone, but unfortunately his patient (see Table, No. 27) died nine hours after the operation ; this is the only instance known to me of any attempt of this nature having been made.

When a patient has undergone the serious ordeal of exarticulation, the removal of the hip-bone by a second operation, should it be deemed advisable, makes a big demand on his vitality and powers of resistance. My second patient died from shock directly due to this, and any operation which may be a possible direct cause of death is one which ought to give us pause to consider whether we should urge it upon a patient.

Morestin operated in 1902 upon a female patient suffering from sarcoma of the pelvis ; the operation was carried out in one stage, and the patient (No. 18) died. In the following year he spoke of it as a 'meurtrière operation,' and suggested that a modification, which he termed the 'intra-iliac' amputation,

might replace the interpelvi-abdominal operation, and especially for those cases of tuberculous disease which require extensive removal of the hip-bone. He has since reported two cases in which he carried out this operation, both of them being done in two stages ; the first patient recovered, and the second died (Nos. 38 and 40).

In this intra-iliac operation Morestin divides the ilium vertically downwards into the sciatic foramen, the horizontal pubic ramus inside the iliopectineal eminence, and the ischium horizontally at the level of the great sciatic foramen ; in this manner he preserves the body of the pubis and the tuberosity of the ischium, attached to each other by their rami ; and in describing the state of his first patient after the operation, he wrote, " the patient can sit and the tuberosity gives him firm support." In his description of the operation, however, he draws attention to the great amount of hæmorrhage owing to the cicatricial state of the tissues which results from the long-continued suppuration and the previous exarticulation, and it does not appear from his writings that this intra-iliac amputation is any less severe than a complete removal of one hip-bone. In *Cases* 1 and 2 of mine, the pubic ramus fractured before the pubic body had been separated from the bone of the opposite side, and the fractured surface of the bone was definitely tuberculous ; this would have been left behind had Morestin's modified operation been carried out. My own inclination is towards a complete removal of the hip-bone in these cases.

I believe there is more justification for the operation in one sitting in what must be the extremely rare cases of acute osteomyelitis of the os coxæ that require removal of the entire bone, although I confess to difficulty in understanding how, in a case of this nature, the operation can be called for. Personally I have only met with two cases of this disease, and in each it was limited to the ilium, as it usually appears to be ; and pus had formed on both surfaces of the bone, as it probably does in all these cases, owing to the comparative thinness of the bone and its cancellous structure. After the removal of practically the whole of the ilium except its acetabular portion, these two patients recovered.

In a case where there was virulent infection on the pelvic aspect of the hip-bone, such as would occur in an acute osteomyelitis, one would hardly expect a patient to be in satisfactory condition for the second operation after a preliminary amputation at the hip-joint. Even in old-standing cases, where the acute stage has been passed, to do the operation in two stages hardly seems the correct procedure, as the bone primarily involved is not removed until the second operation, and the removal of the os coxæ alone is hardly less troublesome than removal of this bone along with the limb, so that the gain in this respect is practically nil. I gather, from the very short quotation of Gaudier's case, "ostéomyélite aiguë coxofémorale, lésions suppuratives étendues ayant necessité la désarticulation interilio-abdominale en deux temps principaux," in the *Zentralblatt für Chirurgie*, 1914, p. 360, that the operation was carried through in two stages ; but the reasons for this, and the length of time that elapsed between the development of symptoms and the carrying out of the operations, are not stated.

With regard to neoplasms, the question of operating in two stages can

only rarely arise. Up to the present time there are only two cases recorded in which the operation has been done in this manner, and both were done for recurrence of sarcoma in the hip-bone or its muscles—(1) After exarticulation at the hip, as in one of Girard's cases (No. 7); and (2) Following an amputation through the shaft of the femur, as in my own case (No. 23). All the neoplasms that have hitherto required this operation have been sarcomata.

Primary sarcoma of the hip-bone almost invariably grows from the ilium, and in cases that are met with at an early stage it may be possible to remove the disease by operations less mutilating in their effect than is the interpelvi-abdominal amputation. I have twice removed the ilium for sarcoma, leaving the acetabular portion. Where the disease is too far advanced for this, a resection of one entire hip-bone, with or without resection of the head of the femur, may be carried out, and the lower limb preserved in a comparatively functional condition. This has, I believe, been done 9 times altogether, with 5 deaths (55·5 per cent) and 4 recoveries.

Where the disease is still further advanced, and in those cases where the neoplasm rises from the upper extremity of the femur or its muscles, the interpelvi-abdominal amputation is the only resource we have to fall back upon; and in these cases it must always be a removal of the limb along with the hip-bone at one sitting.

All the cases of this operation that I can find recorded are included in the list on opposite page. In this list I include the case in which Faure began but did not complete the operation, for it is highly to be desired that all the fatal cases should be known.

The most serious point to be considered with regard to the operation is the question of shock. The amputation entails the greatest mutilation for which surgery is responsible; the wound made is a very large one, and the effect upon the vitality of the patient must always be extremely severe. For this reason I classify the four cases recorded by Nanu (No. 12), Orlow (No. 17), Ransohoff (No. 25), and Krynski (No. 28) as 'surviving'; for although death took place in Nanu's patient on the twentieth day (from sepsis following upon gangrene of the posterior flap), in Orlow's and Krynski's cases on the thirty-fifth day (from sepsis and cachexia respectively), and in Ransohoff's patient on the thirty-eighth day (from sepsis), the four patients survived the immediate effects of the operation.

Freeman, according to his own drawing published in Keen and Da Costa's paper, only removed about one half of the ilium and ischium along with the pubic part of the bone; he sawed through the acetabulum. But the case ought, I think, to be included in this category, as also should Morestin's two cases (Nos. 38 and 40) of the intra-iliac operation. Freeman's patient died twenty months after the operation with metastasis in the abdominal wall (Ransohoff).

During 1915 two patients came under my care upon whom it was considered advisable to carry out the operation. The chief points in their clinical histories are as follows:—

Case 4.—F. McI., age 34, a barber, was admitted on July 9, 1915, to the Royal Infirmary, Glasgow, suffering from a large tumour of the right femur of at least

TABLE OF INTERPELVI-ABDOMINAL AMPUTATIONS.

No.	Date	Operator	Result	Reference
		Cases of Sarcoma.		
1	1889	Billroth	Died 2 hours later	Savariaud, *Rev. de Chir.*, Sept., 1902
2	1894	Jaboulay	Died following day	*Lyon. Méd.*, 1894
3	1894	Cacciopoli	Died 3 hours later..	*Riforma Med.*, 1894
4	1895	Jaboulay	Died 36 hours later	*Province Méd.*, 1895
5	1895	Jaboulay	Died 5 days later ..	Girard
6	1895	Gayet	Died 1 hour later ..	*Province Méd.*, 1895
7	1895	Girard (in 2 stages)	Survived 6 months	*Rev. de Chir.*, 1897
8	1898	Girard	Survived 6 months	*Rev. de Chir.*, 1898
9	1898	Kocher	Died	*Operative Surgery*, 1907
10	1899	Faure	Died	Savariaud, *loc. cit.*
11	1899	Freeman	Survived 20 months	*Ann. Surg.*, 1891
12	1900	Nanu	Survived	*Rev. de Chir.*, 1900
13	1900	Salistcheff	Survived	*Arch. klin. Chir.*, 1900
14	1900	Kadjan	Died second day ..	*Ljstopis Russ. Chirurg.*, 1900
15	1901	Savariaud	Died 2 hours later	*Rev. de Chir.*, 1902
16	1901	Gallet	Died same day ..	*Ann. Soc. Belge de Chir.*, 1901
17	1901	Orlow	Survived 35 days	*Westnik Chir.*, 1901
18	1902	Morestin	Died 9 hours later	*Bull. de la Soc. Anat. de Paris*, 1902
19	1902	De Ruyter	Died same day ..	*Dissert.*, Leipzig, 1902
20	1903	Keen and Da Costa	Died 33 hours later	*Inter. Clin.*, vol. iv, series 13
21	1904	Kocher	Died, collapse ..	*Loc. cit.*
22	1907	Lastaria	Died same day ..	*Riforma Med.*, vol. v.
23	1908	Pringle (in 2 stages)	Survived 5 months	*Lancet*, vol. i, 1909
24	1909	Bier	Survived	*Deut. med. Woch.*, 1909
25	1909	Ransohoff	Survived 38 days ..	*Ann. Surg.*, vol. 50
26	1909	Pagenstecher ..	Survived	*Arch. klin. Chir.*, Bd. 90
27	1909	Axhausen	Died 9 hours later..	*Arch. klin. Chir.*, Bd. 91
28	1909	Krynski	Survived 35 days..	*Centralbl. f. Chir.*, 1910
		Cases of Tuberculous Disease of Pelvis.		
29	1895	Girard	Died same day ..	*Rev. de Chir.*, 1898
30	1897	Bardenheuer ..	Survived	*Verh. Deut. Gesel. f. Chir.*, 1897
31	1900	Gallet	Died 6 hours later	*Jour. de Chir.*, 1901
32	1900	Pringle (in 2 stages)	Survived 14 years..	*Lancet*, vol. i, 1909
33	1902	Ribera (Simon) ..	Died, collapse ..	*Siglio Med.*, 1903
34	1902	Ribera	Died eighth day ..	*Siglio Med.*, 1903
35	1902	Ribera	Died, collapse ..	*Siglio Med.*, 1903
36	1903	Christel (Dreist) ..	Survived	*Deuts. Zeits. f. Ch.*, Bd. 71
37	1905	Verneuil	Died 2 hours later	*Jour. Chir. Belge.*, vol. v, 1905
38	1905	Morestin (in 2 stages)	Survived	*Bull. Soc. Chir. Paris*, vol. xxxiv
39	1906	Pringle (in 2 stages)	Died 14 hours later	*Lancet*, vol. i, 1909
40	1909	Morestin (in 2 stages)	Died 5 hours later	*Bull. Soc. Anat. Paris*, vol. lxxxiv
		Case of Acute Osteomyelitis.		
41	1913	Gaudier (in 2 stages)	Survived	*Bull. Soc. Chir. Paris*, 1913, n.s.

In the Index Medicus for 1910 there is a reference to a case operated by Sinakevich, and reported in *Khirurgia Mosk* for 1910, "Excision of entire lower extremity together with pelvis." No further details accessible.

ten months' duration. When he first observed it, it was about the size of his fist, and situated in the lower part of Scarpa's triangle. He has only had pain within the last few weeks, and chiefly after walking or standing. For the past month or more he has had difficulty in putting on his socks and boots, as he cannot flex his right hip-joint owing to the bulk of the tumour.

He contracted syphilis sixteen years previously, and took mercury for three

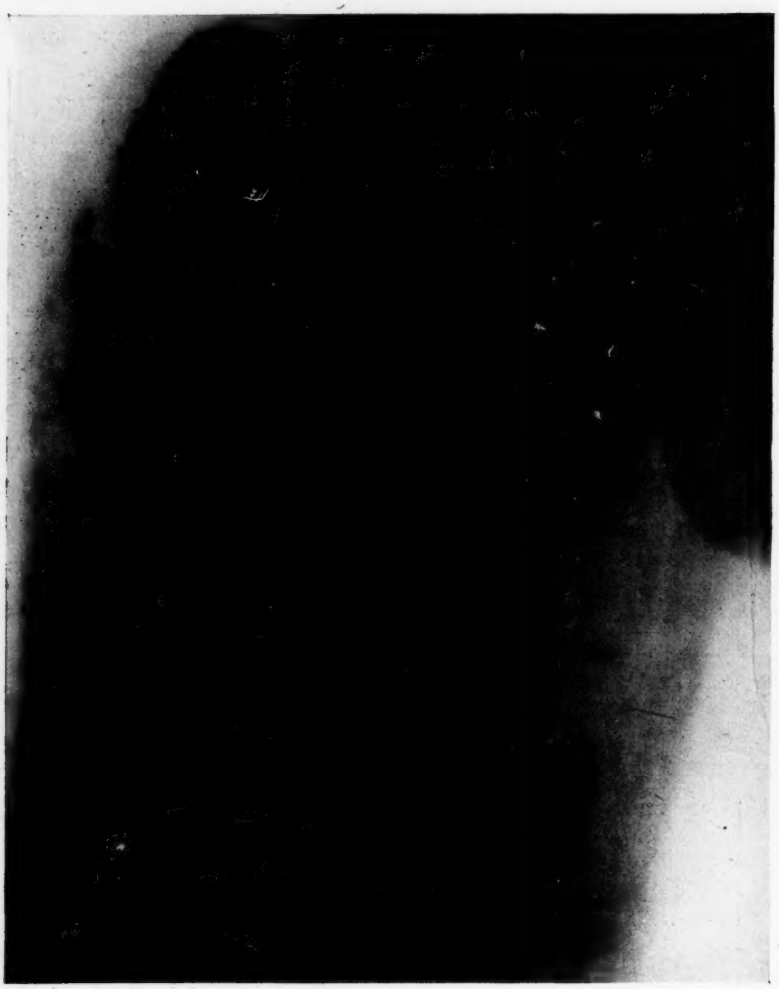

FIG. 191.—*Case* 4. Skiagram showing tumour of the neck and upper third of the femur, and its relation to the hip-bone.

years. The Wassermann reaction is positive. He admitted being a hard drinker and smoker.

There is a very large tumour occupying the upper two-thirds of the right thigh, causing a very marked prominence anteriorly as well as at the sides of the thigh; it reaches up to Poupart's ligament, filling Scarpa's triangle. Firm in consistence, on the whole, but elastic in parts and somewhat nodulated in outline, it can be felt reaching almost to the summit of the great trochanter outside, and on the inside up to the ramus of the ischium. Flexion, adduction, and internal rotation at the

hip-joint are practically abolished. The skin over the tumour is normal in appearance. He suffers from a widespread psoriasis.

The skiagram (*Fig.* 191) shows the relations of the tumour to the hip-bone and femur. It was considered to be a chondrosarcoma. The patient's internal organs were normal, and no evidence of growth into the pelvic cavity could be obtained.

July 24.—The interpelvi-abdominal amputation was done (*vide infra*).

The appearance presented by section of the femur and the tumour is shown in *Fig.* 192. The tumour grew from the neck and upper third of the femur, the tissue of which was almost completely replaced by it. In the main the tumour appeared to be cartilaginous, but there were a few cystic spaces in it.

The patient made an excellent recovery. He suffered very little from shock. The stovaine along with the scopolamine and morphine acted well, and he only had a small quantity of ether during the early stages of the operation. He went out of the hospital well (*Fig.* 193).

Case 5.—Mrs. H., age 46, was admitted to the Royal Infirmary on July 27, 1915, with a large tumour in the right thigh. She first noticed the swelling about twelve months before, but paid little attention to it until it began to enlarge more rapidly in January, 1915, and to cause pain. On July 17, without making any special effort, she experienced severe pain in the thigh, and since then has not been able to walk or even to move the limb, and has been confined to bed in consequence. During the last ten days the tumour has increased in size rapidly.

She is much emaciated, and often vomits after food ; after admission she was only able to take the lightest food without vomiting.

The right thigh is occupied by a large tumour, the prominence of which begins immediately below the anterior superior spine, and extends rather more than half way down the thigh. The skin of the thigh is dusky red in colour, large veins stand out prominently all over it, and in the sacral region the skin has the appearance as if it were about to slough.

FIG. 192.—*Case* 4. Section through the tumour and the femur of the amputated limb.

The patient can only lie upon her right side, and is unable to move the right limb at all ; any attempt to move it causes great pain. The tumour has an elastic feeling all over, and nowhere is it fluctuant. It extends well up into the gluteal region behind the trochanter, as well as into the adductor muscles at their origins

(*Fig.* 195—which, however, does not show the real extent of the growth as found on palpation).

The internal organs were all normal, and no pelvic extension could be discovered.

On Aug. 3, 1915, the complete interpelvi-abdominal amputation was done. The patient, having had scopolamine and morphine one hour before, had a spinal

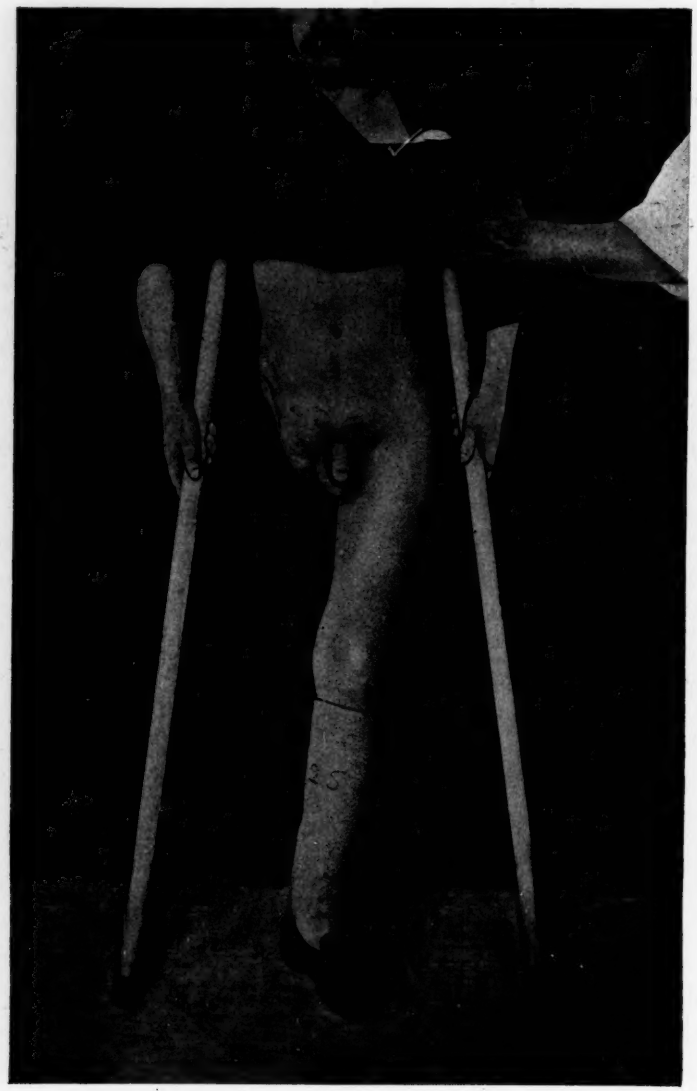

FIG. 193.—*Case* 4. The patient after interpelvi-abdominal amputation of the right limb.

injection of stovaine after being brought to the theatre, and had no general anæsthetic at all. She exhibited a certain degree of shock after the operation, much more than did the man, but got over it fairly quickly. She was greatly troubled with vomiting, for several days following, which caused some anxiety; but after this was got over she made a first-rate recovery.

She went out from hospital on Sept. 18, very well.

The tumour was myxomatous in character: it had led to a complete fracture of the shaft of the femur just below the trochanter minor (see *Fig.* 195).

Both this and the tumour of the former patient were examined histologically. The pathologist's report regarding both of them was that evidence of malignant disease could not be found in the parts examined. The comparatively rapid development in each case, and especially the fracture of the femur

FIG. 194.—*Case* 4. Skiagram of the pelvis after interpelvi-abdominal amputation of right limb. The ilium was sawn through and the posterior part left.

in the case of Mrs. H., made me think there was no doubt as to the malignant character of the neoplasms.

The points that particularly arise for consideration in connection with this operation are: (1) The prevention of shock; (2) The flaps to be cut; (3) The amount of bone to be removed; (4) The control of hæmorrhage.

1. *Shock* has been the cause of by far the greater number of deaths, and

is the chief factor to be reckoned with after the operation. With my three patients operated on for neoplasms I endeavoured to overcome this risk by:

FIG. 195.—*Case* 5. Skiagram showing tumour of the upper part of the femur, with resulting fracture of the shaft.

(1) The use of scopolamine and morphine beforehand; (2) Spinal anæsthesia (stovaine); (3) The infiltration of the large nerve trunks with novocain before they were divided; (4) The intravenous injection of saline solution before the

completion of the operation; and (5) Operating upon patients while they were lying upon a warmed table.

Probably each of these factors helped; at any rate the patients survived.

2. *The Flaps.*—Quite a number of methods of cutting flaps have been employed by the surgeons who have carried out the operation. In some of the cases, owing to the size and position of the tumour, it has been a question of

FIG. 196.—*Case* 5. Skiagram showing the pelvis after interpelvi-abdominal amputation with entire removal of the right hip-bone.

cutting flaps where they could be obtained. I think, where one has the choice of method, that the flaps should be of nearly equal length, and that they will be most advantageously made anteriorly and posteriorly.

In my three neoplasm cases (*Cases* 3, 4, and 5) I cut flaps that were identical, and which I arrived at from the experience obtained with the two cases of tuberculous disease (*Cases* 1 and 2). In each of these I incised along

the scar resulting from the exarticulation of the hip, and prolonged the incision up to the crest of the ilium (which was met at about its middle point), and thence along the crest to the posterior superior spine. In *Cases* 3, 4, and 5, I cut flaps which were, as nearly as possible, similar to these, and they proved to be admirable in each instance. In the two male patients, in whom the ilium was sawn, the flaps were perfectly adapted. In *Case* 5 (the female patient in whom the ilium was disarticulated from the sacrum) the posterior portion of the wound was just a trifle baggy when the suturing was completed, but the stump is, at this date, quite excellent.

3. *The Amount of Bone to be Removed.*—Some surgeons have disarticulated at the synchondrosis, and others have sawn the ilium; while anteriorly, in some cases the symphysis has been divided, and in others the pubic rami.

In the case of a neoplasm growing primarily from the ilium, I believe it is essential that the operation should be an exarticulation at the synchondrosis, and possibly in some cases part of the sacrum ought to be removed as well.

Whether the pubic bones ought to be disarticulated from one another at the symphysis, or the rami of the os pubis divided with the object of preserving the attachment of the rectus abdominis, may in some degree be determined by the site and extent of the tumour, though it will probably always be better to remove the entire os coxæ. Although in *Case* 3 I preserved the body of the os pubis with the idea of saving the rectus attachment, I do not now think it is necessary to do so; for the result of suturing this and the other muscles of the abdominal wall to the levator ani and to the fascia over the sacrum apparently gives quite adequate support to the abdominal viscera.

In the case of a neoplasm arising in the thigh, the question whether the whole or only part of the hip-bone should be removed must be decided according to the state of things found to exist in any given patient; thus, in *Cases* 4 and 5, I divided the symphysis in front because the disease appeared to have invaded some of the muscles taking origin around the obturator foramen (***Figs.*** 191 and 195); and whereas I sawed the ilium in *Case* 4 (***Fig.*** 194) because the tumour was placed well away from the gluteal region, in *Case* 5, because the tumour seemed to have invaded these tissues (***Fig.*** 195), I disarticulated the ilium from the sacrum (***Fig.*** 196).

From my experience in *Cases* 3, 4, and 5, I think it requires less time to saw the ilium than to disarticulate; and that disarticulation from the gluteal aspect goes more easily and quickly than from the pelvic side.

4. *The Control of Hæmorrhage.*—My opinion regarding this point is that all that is necessary to do is to tie or clamp the vessels as one meets them during the progress of the operation.

In *Case* 3, after shaping the anterior flap, I divided the muscles along the iliac crest, and went directly to the common iliac vessels, which I divided between two ligatures; but I wrote in my former paper, that "the advisability of doing this is uncertain . . . should I ever have occasion to do this operation again, I think I would not waste time by exposing the vessels during the early stages of the operation." In the two cases now recorded I put this idea into practice, that is, I clamped with pressure forceps the smaller vessels as they were encountered, and tied the common iliac vessels just before they required to be divided. Both patients really lost very little blood, and what blood was lost was due chiefly to oozing from the posterior flap.

Some of the Continental surgeons responsible for the more recently published cases have greatly lauded the advantage to be gained in this operation by the employment of Momburg's method of controlling the circulation in the lower part of the body. I have had a small experience of Momburg's method, having employed it now in ten cases, three being high amputations in the thigh, and seven exarticulations at the hip-joint, and have been highly pleased with it. It affords perfect control of the vessels, and in no single case have I seen any of the inconveniences or disturbances of function that have been attributed to it by some surgeons. In *Case* 5 there was, after the operation, most troublesome vomiting, and had the Momburg method been employed there is little doubt but that this would have been considered the cause of it. But in spite of my experience of the method, I should not be inclined to use it in a case of the interpelvi-abdominal amputation; and in the case of a large neoplasm filling the iliac fossa and reaching above the crest, the Momburg method might not be practicable.

Technique.—The procedure I adopted in my last two cases (*Cases* 4 and 5) was practically the same in each, and was as follows :—

The patient was turned slightly on to the sound side, to allow the incision to be commenced at a point just behind the posterior superior spine, whence it ran along the iliac crest to about midway between the two superior spines, and thence to a point in the cruroperineal groove corresponding to the centre of origin of the adductor brevis muscle, the line of incision lying about an inch and a half below the anterior superior spine, Poupart's ligament, and the pubic spine respectively.

The anterior flap of skin and subcutaneous fascia was reflected far enough to expose the attachments of the abdominal muscles to the iliac crest and Poupart's ligament; then, beginning at the crest, these muscles were at once cut through, Poupart's ligament was divided at each end, and the rectus abdominis also cut, after drawing the spermatic cord aside (in the female the round ligament was not seen). The deep circumflex iliac and epigastric vessels were tied close to their origins, and the external iliac artery was clamped just above this point; but the external iliac vein was left free, to allow of as much blood as possible being returned from the limb.

Then, while the limb was well elevated, the posterior flap was marked out, from about the mid-point between the anterior and posterior superior spines down to the gluteal fold, which was followed to meet the inner extremity of the anterior incision in the cruroperineal groove. This flap of skin and fascia was reflected back so far as to expose the ischial tuberosity, in order to obtain room to deal with the perineal structures.

The bladder was next separated from the pubis, and an attempt made to cut through the symphysis. In *Case* 4 (the male patient) there appeared to be a complete synostosis, and I had to saw the bone; in the female (*Case* 5) the symphysis was partly cut through, but division had to be completed with a saw. Next the genital crus and the tissues of the perineum were separated from the pubic arch. The pelvic organs were well retracted to expose the obturator nerve and vessels, and both this nerve and the femoral were now injected with novocain solution; the obturator vessels, and then the common iliac artery, were next tied and divided, and the external iliac vein was tied above

Poupart's ligament, divided, and lifted up from the muscles in the iliac fossa, which were cut just outside the sacro-iliac articulation.

The femoral and obturator nerves were next divided, then the visceral layer of the pelvic fascia and the levator ani muscle, the latter being separated back to the ischial spine, and the coccygeus muscle was cut through. The patient was now turned further over on to the side, and the posterior flap reflected to rather beyond the synchondrosis; the gluteus maximus was cut through, and, in the case of the male patient, the ilium was then sawn about an inch outside the sacro-iliac articulation. The roots of the sciatic nerve were now infiltrated with novocain, the larger branches of the hypogastric vessels ligated and divided, and then the piriformis muscle, the roots of the sciatic nerve, and the sacrosciatic ligaments were cut through. In the male patient this set the limb free. In the female, the disarticulation of the ilium from the sacrum, carried out from the pelvic aspect, followed the division of the piriformis and the nerves.

While I proceeded to tie vessels that were held in forceps, my colleague, Mr. John Macintyre, injected about two pints of saline solution through the external iliac vein, which had been kept long specially for that purpose.

Suture of the muscles of the abdominal wall to the fascia over the sacrum, as well as to the levator ani muscle and the tissues of the perineum, followed by suture of the skin—a large drain tube being left at the posterior angle of the wound—completed the operation, which lasted fifty-five minutes in the male and about sixty minutes in the female, the difference being mainly due to the extra time required to disarticulate the synchondrosis in the latter patient.

Both patients were seen in August last, when they were in good health. Both have put on weight. Their stumps were excellent, without any tendency to hernia formation. In neither of the patients could any evidence of recurrence be detected.

I particularly enquired as to the support afforded by one half of the pelvis while sitting. Both of them stated they were able to sit upon a hard chair without any discomfort until an attempt was made to lean over towards the operated side, when they lost their balance. They are able to overcome this disability entirely by the use of a cushion beneath the stump.

When my first three cases were recorded in 1909, up to which time I had been able to collect twenty-one additional cases, there was a total mortality of 75 per cent; or, taking the cases of neoplasms alone, a mortality of 67 per cent in the nineteen cases known. If one compares these results with those of the cases known to have been operated up to the present time, it will be seen that a great improvement has taken place; over the total forty-three cases there is a mortality of 58·1 per cent; or, taking the cases of neoplasms alone, a mortality of 56·6 per cent, a very remarkable reduction.

There has scarcely been a single operation of any magnitude that has not in the early stages of its development been looked at askance, and the inter-pelvi-abdominal amputation must always remain one of the severest in surgery. But, if the real nature of these cases be recognized at an early stage, and the operation can be carried through before the patients have commenced to run down in consequence of the disease, the mortality following it will, I believe, be so far diminished that justification of the operation will in the future be generally admitted.

TWO CASES ILLUSTRATING THE EFFECTS OF ROTATION OF THE POINTED BULLET AROUND ITS TRANSVERSE AXIS.

By Surg.-Gen. Sir GEORGE H. MAKINS, K.C.M.G., C.B.
Consulting Surgeon A.M.S.

Case 1.—**Bullet Wounds of both Arms.**

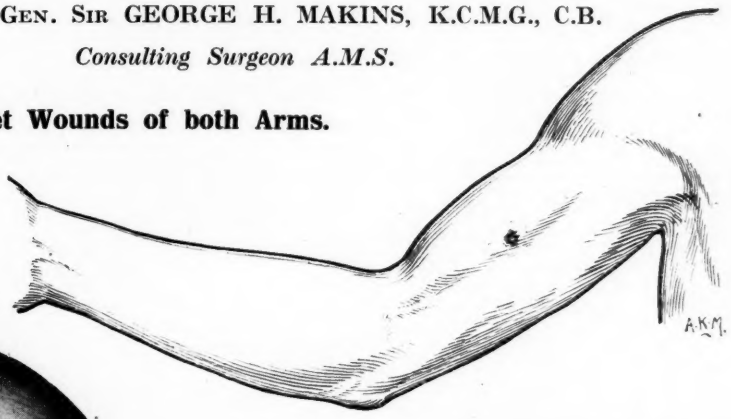

Fig. 197.—*Case* 1. Bullet wound of right arm showing the aperture of exit.

Fig. 198.—*Case* 1. Gutter wound of left arm produced by a pointed bullet.

Figs. 197 and 198 show the varying lesions produced by the passage of the same bullet through both arms of the patient. The outline drawing depicts a small aperture of exit at the margin of the right biceps muscle. The entry wound on the outer aspect of the limb was of the type variety produced by a bullet impinging with its point at a right angle to the body surface. In the course of its passage across the trunk the bullet has presumably turned on its transverse axis, producing a lesion in the left limb comparable to an actual incision by a knife. The deep gutter wound involved nearly the whole thickness of the biceps muscle and a corresponding extent of the superjacent skin. The vessels and nerves of the arm escaped injury.

Case 2.—**Bullet Wounds of both Legs.**

Figs. 199–204 illustrate a similar injury in the lower extremity. The patient was under the care of Lt.-Col. Gordon Watson and Capt. Frazer.

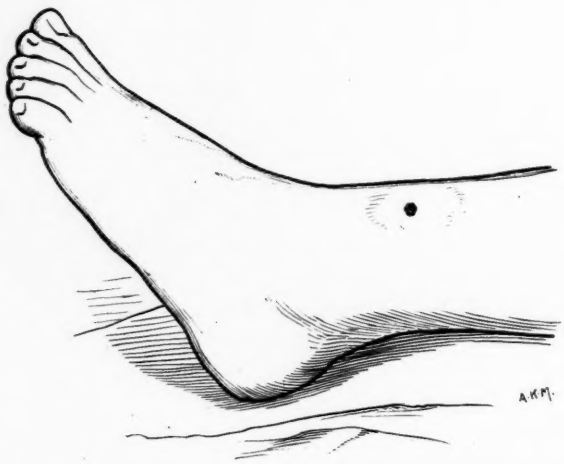

FIG. 199.—*Case* 2. Bullet wound of left leg: aperture of entry.

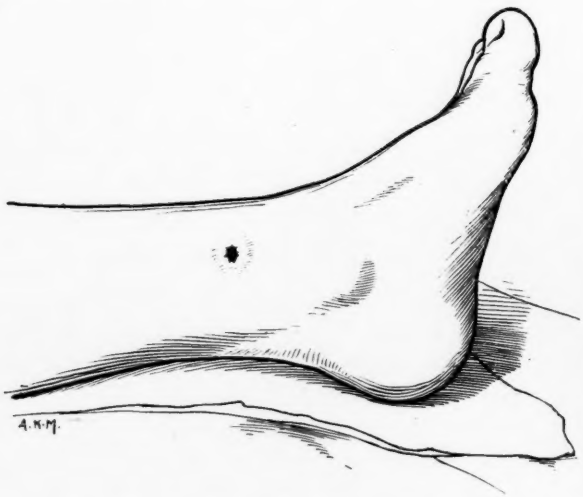

FIG. 200.—*Case* 2. Bullet wound of left leg: aperture of exit.

FIG. 201.—*Case* 2. Skiagram showing the fracture of the left tibia.

The two outline drawings (*Figs.* 199, 200) show typical apertures of entry and exit in the lower third of the left leg just above the ankle-joint. It will be remarked that the aperture of exit is small, in spite of the fact that

the bullet traversed the left tibia, occasioning a fracture of the bone, accompanied by both comminution and fissuring (*Fig.* 201). The facts that no traces of metal are to be seen in the skiagram, and that the size of the

FIG. 202.—*Case* 2. Aperture of entry in right leg caused by the lateral impact of the bullet.

FIG. 203.—*Case* 2. 'Explosive' aperture of exit in right leg.

exit wound is small, appear to prove that the bullet underwent little or no deformation in its passage through the limb.

FIG. 204.—*Case* 2. Skiagram showing comminution of the right tibia and fibula—the malleoli completely blown away.

In crossing the interspace between the two limbs the bullet turned upon its transverse axis, striking the right limb at a slightly lower level broadside on. *Fig.* 202 shows the aperture of entry, which corresponds fairly accurately with the outline of the bullet, while *Fig.* 203 depicts a typical triangular 'explosive' exit wound, involving the junction of the leg with the dorsum of the foot on its outer aspect. The skiagram (*Fig.* 204) shows very extensive comminution of both bones of the leg, involving the ankle-joint and causing destruction of both malleoli. The absence of any traces of metal in connection with the fracture indicates here also that the bullet itself suffered very little injury in its passage across the second limb, although the degree of damage to the bones, and the nature of the wounds in the soft parts afford evidence that a considerable degree of velocity of flight was still retained.

The production of injuries of this character by a normal pointed bullet on the soft parts of the limbs explains the mechanism of the extensive cavernous wounds occasionally met with in the solid abdominal viscera, as also the complete severances of continuity of the intestinal canal, sometimes occurring in association with typical small apertures of entry and exit in the abdominal parietes.

SARCOMA OF THE STOMACH: RESECTION.

By L. E. BARRINGTON-WARD, London,

AND

ERNEST H. SHAW, London.

Primary sarcoma of the stomach, although not the rarity it was once thought to be, is still sufficiently uncommon. Paterson considers that sarcoma forms four per cent of primary neoplasms of the stomach. Aaron stated in 1911 that there had been twenty-six cases of resection for sarcoma recorded, with eleven successful results.

The condition is not as a rule diagnosed beforehand. In the case about to be recorded, there were certain facts—the age and sex of the patient, the analysis of the stomach contents, the remarkable anæmia and wasting—that made one suspect before opening the abdomen that this was not a straightforward case of either gastric carcinoma or ulcer.

The patient, a male, age 25, was admitted to hospital on Jan. 27, 1916, complaining of indigestion of some five or six years' duration. He suffered from pain in the epigastrium and flatulence after food. He stated that for nine months he had been free from pain, but for three weeks before admission the pain after food had attacked him again, and was much more severe; it lasted from fifteen to twenty minutes. He had twice vomited coffee-ground material. His stools on one occasion were of a tarry colour. He was constipated. He was very thin, and extremely anæmic. He had lost a stone in weight in the last three weeks. Medical treatment had been of no avail.

Examination of the abdomen revealed nothing except slight tenderness on pressure over the upper part of the left rectus muscle; no tumour could be felt. The stomach contents were examined: free HCl was present, no lactic acid, no mucin; total acidity, 0·2 per cent; microscopical examination showed a few yeasts and a few Boas-Oppler bacilli. The contents, therefore, appeared normal. A bismuth meal was given, and radiographic examination showed no delay in stomach or small or large intestine. The other systems were normal.

Despite these negative findings, his history and general condition made an exploratory operation seem advisable, and on Feb. 1 the upper half of the abdomen was opened by displacing outwards the right rectus muscle. The stomach was of average size, and had a normal appearance. On palpation, a soft lobulated body the size of a golf ball could be felt floating within the stomach; it was remarkably mobile, and could be pushed freely in all directions; it gave at first the impression of a free foreign body, but on more careful examination it was felt to be attached near the pylorus. There was an enlarged gland on the lesser curvature, and one or two in the lower part of the great omentum. The peritoneum everywhere was normal, and the only outward

sign of the tumour was a projection on the lesser curvature. The liver seemed normal.

As the nature of the tumour was uncertain, the stomach was opened, and a soft, round, but lobulated growth was found projecting into the organ; it was attached by a fairly broad base to the anterior and posterior walls about one inch from the pylorus. The growth ran in a nodular way along the pyloric half of the lesser curvature. At the most prominent part of the tumour were two small superficial ulcers, possibly traumatic in origin. The tumour must have acted like a ball-valve to the pylorus.

It was obviously impossible to do a local excision with any prospect of success, and therefore the stomach was closed with two rows of sutures. The duodenum was then divided one inch from the pylorus, and the stomach divided along a line running from the lesser curvature, just to the right of the œsophagus, to the junction of the left and middle thirds of the greater curvature.

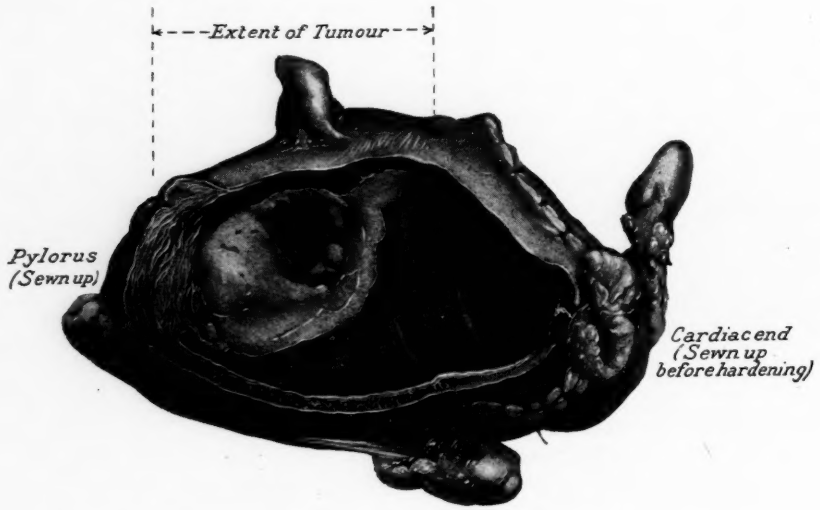

FIG. 205.—Stomach with anterior wall removed, showing tumour *in situ*.

The omenta and the lymphatic tracts were removed as freely as possible. A posterior anastomosis was made between the jejunum and the remains of the stomach. Catgut was used throughout. A small rubber drain was inserted (for twenty-four hours), and the abdomen closed. The patient's condition was excellent at the end of the operation, which had lasted one hour and twenty minutes.

The subsequent course was uneventful. The patient was given rectal salines with glucose for thirty-six hours, and was then also allowed water by the mouth. On the fourth day his bowels were opened, and he was given peptonized milk; rectal salines were given four-hourly. On the fifth day, owing to his dislike of the peptonized milk, he was given equal parts of milk and water. On the sixth day salines were discontinued. The diet was gradually increased; on the ninth day the patient was taking chicken with relish. On

the tenth day he was allowed up, and a few days later left hospital for a convalescent home.

It is too early yet to speak of a cure in this case. The disease, so far as could be ascertained with the naked eye, was confined to the stomach (the largest gland was examined microscopically, and was not found to be sarcomatous); it will be interesting to see if the radical treatment of sarcoma of this organ offers a brighter prospect than the treatment of sarcoma in other parts of the body.

PATHOLOGICAL EXAMINATION (E. H. S.).

The specimen (*Fig.* 205) consists of a portion of the stomach. There is a nodular white growth projecting from the peritoneal surface of the lesser curve. On removal of the anterior wall a large irregular tumour is seen projecting into the stomach from the region just below the above growth. The tumour has a broad base, and is covered with mucous membrane; the latter is ulcerated in two places over the centre of the growth. In the course of its growth the

FIG. 206.—Microscopical section of the tumour, showing round-celled sarcoma.

tumour has lifted the mucous membrane off the muscular coat, and has burrowed along between these layers for some distance around its base. The tumour is solid, and white for the most part, but there is a large hæmorrhagic patch near the base. An ill-marked lobular arrangement can be seen running through the growth. The remainder of the stomach appears to be normal.

MICROSCOPICAL EXAMINATION—The growth consists of a collection of small round cells lying in a fibrillar and fibrous matrix (*Fig.* 206). It is a round-celled sarcoma.

ON THE TREATMENT OF WOUNDS OF THE THORACIC DUCT.

By EDWARD HARRISON, Hull.

Tom W., age 9, was admitted into the Hull Royal Infirmary, Jan. 25, 1916.

On Admission.—A pale, very emaciated little boy, with a transparent skin, and with a temperature about 102° each night. The left side of the neck was occupied by an enormous mass of glands reaching from the clavicle to the angle of the jaw. The largest of these were in the posterior triangle. He stated that he had been in the Infirmary before and had glands removed from the same site, and there was a cicatrix running over them. We could not, however, find the former notes of the case.

Operation, Feb. 2.—An incision was made from the clavicle to the angle of the jaw. After reflecting the skin and platysma, the sternomastoid was seen as a thin ribbon of muscle and was also reflected without division. The external jugular vein was very large, and was divided at about the junction of the middle and lower thirds of the incision.

After opening the capsule the glands shelled out fairly readily—by blunt dissection mainly, a great deal of this being effected by the gloved finger. The scalpel which I had to use now and then to divide the capsule was a round-ended one. I always use this form of knife in glandular dissection, as one is far less likely to prick a vein. The dissection was conducted with great care, as the tumour was closely pressed against the jugular vein, and extended downwards behind the clavicle, where the enucleation was done entirely with the fingers. There was no trouble with hæmorrhage, and everything seemed to be progressing smoothly, until the main mass was removed from the posterior triangle, when a small quantity of what looked like pus was seen in the wound just above the clavicle. The glands did not feel at all like suppurating ones, as there were no adhesions, and after the tumour had been taken away and the wound mopped out, the milky fluid again collected. We then saw that it came from the divided end of a vessel, of which about two inches were exposed, which was somewhat less in diameter than a small straw.

It was clear now that the thoracic duct had been divided, and the chyle was dripping out of the divided end and might have been collected in a spoon. I thought at the time that the tumour must have pulled the duct up into the neck, but now I am inclined to the opinion that it was one of the anomalies mentioned by Henle.

The question now was what to do with it? I had not read, perhaps fortunately, any of the cases of this accident which had been reported, and it seemed to me that unless I could implant the duct into a vein the lad was doomed to die of starvation. The external jugular had been divided, and the lower end was ligatured a little more than an inch above the clavicle, so I decided to make use of this. A small clamp was first applied to the vein, just

above and behind the clavicle, and the ligature then removed from it. The vein was about a quarter of an inch in diameter when flattened out, and was so situated that the divided duct could be readily dipped into it without any tension. Using three of the finest intestinal needles, sutures were passed through the opening in the vein, and each needle then caught up the duct about half an inch from its open end (*Fig.* 207). Care was taken that there should be no twisting of the duct when it was implanted. The vein was then held open by the three sutures, and with fine forceps I pushed the divided end of the duct into the open vein, holding it in position while the house surgeon tied the sutures. The space between two of the three sutures was longer than the other spaces; this was purposely made, as the size of the lumen of the two vessels was so different. This loose portion of vein was separately sutured, and all looked nice and snug. The clamp was then removed from the vein, and there was no leaking.

The remaining glands were now shelled out; they extended up behind the jaw to very near the facial nerve. The wound was then closed, a small drain being inserted at the lower angle. The operation lasted exactly an hour, and the patient took the anæsthetic well, there being no trouble in that respect.

The following report has been received from the Clinical Research Association: "This gland is profoundly altered in character, owing to the replacement of the lymphoid tissue by connective tissue, large endothelial cells, and occasional vessels with hyaline walls. The general appearance is that of the advanced lymphadenoma type of gland, and we see no reason to regard it as a malignant growth in the usual sense."

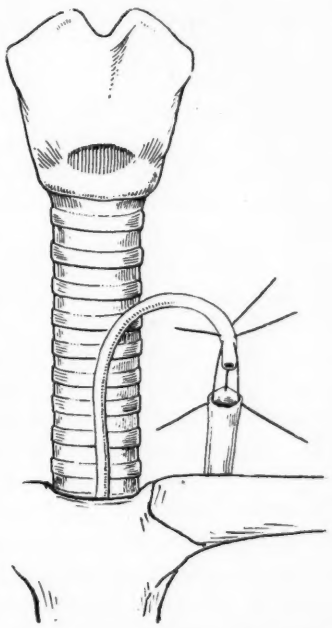

FIG. 207.—Showing the method of suturing the thoracic duct to the external jugular vein.

PROGRESS OF THE CASE.—On the day of operation, and on the following one, the temperature became normal, after which it reverted to its old level of about 102° in the evenings. The wound healed by first intention, and the boy expressed himself as feeling very much better; he took his food well, and on the sixth day wished to get up. From the tenth to the seventeenth day he wore a poroplastic splint to fix the neck. This was done to prevent, if possible, the separation of any clot which might have formed at the junction of the duct with the vein: the thirteenth day is a critical one for this accident to occur. He remained in the Infirmary for several weeks, during which time he took his food well, tonics and cod-liver oil being exhibited. He gained several pounds in weight; but his temperature maintained its high level. He was discharged to his home in the country.

The text-books scarcely mention this injury; indeed, in such a voluminous

work as Jacobson's, it is only in the last edition that the subject is dealt with at all; yet there have been some fifty cases recorded, and many papers written, as will be seen by the bibliography appended. It will be well then, before discussing the methods of treatment to be adopted, to review briefly the more important of these communications.

Harvey W. Cushing,[8] of Baltimore, in the *Annals of Surgery*, says that wounds of the thoracic duct are given but the most cursory mention in the standard text-books of surgery. König gives none, and Tillman but the barest reference to them. Treves, in a paper read before the Johns Hopkins Medical Society, March, 1898, states that in every case death must follow (in a period of weeks rather than months) from marasmus, consequent upon the discharge, and that the treatment is purely symptomatic. The American view is much the same, and generally is to the effect that a wound of the thoracic duct is beyond surgical treatment.

Cushing relates particulars of two cases of operation wounds—one a case of Halsted's, where the wound was not noticed at the time of operation, and treatment by packing was successful, though the patient died some months later from internal metastasis. In his own case a slit-like wound was made longitudinally in the duct, and was immediately sutured, with a satisfactory result. After detailing nine cases, Cushing recommends the following treatment:—

"When working near the duct, all visible lymphatics should be tied. Those which may be large enough and near enough to the main duct to subsequently allow of an escape of chyle might have no apparent leakage at the operation, as under ordinary operative conditions the milky product of the lacteals is absent from the lymph stream. If the duct itself is injured, suture is the ideal method, but must be confined to those fortunate cases in which the duct is fully exposed and has not been completely divided. If suture is impossible, and the wounded vessel is a large one, it is safest to treat it as though it were the main channel. It would seem advisable to place a provisional ligature about the duct on the proximal side of the wound, and to control the leakage, if possible, by a gauze tampon. This would act as a safety valve, and allow chyle to escape, if the pressure in the duct became too great, and there was difficulty in establishing a collateral lymphatic circulation. The patient meanwhile should be given a meagre diet. If the leakage should become uncontrollable and threaten starvation, the provisional ligature should be tied, with the hope of a final readjustment of the collateral circulation or trusting in the presence of some anomalous anastomotic branch which might suffice to carry the lymph into the venous circulation."

Henry P. De Forest[11] considers that by far the most valuable contribution to this subject is made by Dr. F. Lotsch, who says that a wound of the ductus thoracicus at a point near its outlet is an always rare complication of operations upon the left side of the neck. The first recorded observation was made by von Boegehold[2] in 1883, and was to the effect that with the exception of a case observed by himself, he had never seen a reference to wounds of the thoracic duct in the neck, although, with the extirpation of large tumours in this region, such an accident can easily happen.

In 1905, Unterberger[39] collected 30 cases, and remarks upon them concerning the course and topography of the extra-thoracic portion of the thoracic duct. The duct passes on the left side of the œsophagus in the cephalic aperture of the thorax. At the level of the sixth vertebra it turns, sometimes in an acute, and sometimes in an oblique curve, upward and forward, and terminates in the angle of junction of the left subclavian with the jugular vein. Shortly before its termination it receives the lymph duct coming from the left side of the head and neck, as well as that of the left arm, finally also the truncus lymphaticus mammarius sinistra.

In the wounds of the duct which have occurred during operations, it has frequently happened that the chylorrhœa has not developed for some hours, or even days, after the operation. In these cases, probably, the wound has been a slit which has been temporarily closed by blood-clot.

The amount of chyle which escapes is enormous. In a case of Thoele's the patient was literally deluged in chyle.

The disease picture which develops has been observed and described several times.* The digestive organs work in vain. Hunger and appalling thirst develop. Ingestion of food is followed by a marked increase in the chyle, which forms and escapes. Emaciation and progressive loss of strength, weakness of the heart action, and finally loss of consciousness, follow as a result of such a condition. There is some fever, whether due to the absorption of nucleins and albumins is uncertain. Notwithstanding all this, the cases sometimes make a slow recovery, which must be due to the anastomoses existing between the ducts of the two sides and gradual dilation of the channels.

De Forest recommends that treatment should be the same as for a wound in a blood-vessel—that is, ligature, suture, suture of the enclosing tissues, clamp, and compression by tamponade. This seems to me a most surprising statement, especially as he goes on to state, " the implantation in the vein of a duct which has been cut across (Schopf[31]) is scarcely possible on technical grounds, and has completely failed in satisfactory results."

Of the 30 cases mentioned by Unterberger, all were treated by one or other of these methods, and it is astonishing to hear that only two died ; but many of them resisted treatment for a considerable time.

Dr. J. H. Brinton,[3] in a paper on ' The Surgical Relations of the Thoracic Duct in the Neck," gives a detailed account of the various ways in which the thoracic duct empties into the veins. He states that at the mouth of the duct in the wall of the vein there are two valves which prevent the back flow of blood into the lymph channel. There are, however, frequent anomalies. Sometimes it empties into the right side, and sometimes there are several openings into the vein, producing a sort of delta.

Dr. W. W. Keen,[18] in another article in the same journal, " Operation Wounds of the Thoracic Duct in the Neck," says the danger of wounding it may be greatly increased by the fact that Dieterich (Henle's *Anatomy*, 1876, iii, 453) has found the arch of the duct as much as five and a half centimetres—

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* Wendel, Schwinn, Schroeder-Plummer, Schopf, Ricard, Thöle.

over two inches—above the top of the sternum, and touching the thyroid gland. He reports four cases, two of which were his own. They were all treated by closure of the duct or plugging. One died and three recovered.

W. J. Stuart[36] has collected 42 cases, which clearly include the 30 already mentioned of Unterberger's. All these seem to have been treated by closure of the divided duct, and he puts the mortality at 7·5 per cent.

In *Keen's Surgery*, vol. vi, p. 321, it is stated that "Quain, Wendel, and others have found the outlet of the thoracic duct double or delta-formed in many cases. This explains why the injury of one branch does no serious harm if it be ligated. Recently, Parsons and Sargent have made dissections of forty subjects carefully injected. In almost half of the number (18 out of 40) the duct had two branches; 9 of these had the branches reunited; 7 had two insertions into the vein; 2 had four insertions. Verneuil found the duct branched in 6 out of 24 cases; Wendel, in 8 out of 17 cases. As there are often also anastomoses with the azygos vein deep in the chest, or with a duct on the right side, it is easy to see why simple ligation of the duct when it has been wounded has been followed by so many cures. Fredet reports 58 cases collected from the literature, with 5 deaths. Van Bockstaele tied the duct, which he had severed in operating for a large sarcoma, but had a fistula in two days. This refused to close on cauterizing with zinc chloride, but healing and rapid recovery followed the injection of a strong solution of antipyrin. Garré also reports a case of fistula, which was cured by cutting down and removing an infected ligature on the duct."

In 1912, Zesas[48] published the most complete recent paper on the subject. After reviewing the recent work on the anatomy of the duct, he gives details of 49 cases, and he describes four methods of treatment, as follows: (1) Tamponade; (2) Ligature, or compression by forceps; (3) Repair of the wounded duct; (4) Implantation into a vein.

Regarding tamponade, he says there were 21 cases: of these, 3 died, 14 were defective, as loss of lymph continued from a fistula, and in 4 there was immediate success, but it is questionable whether this was not due to the small nature of the injury. Of 13 cases of ligature, success was immediate in 9, and in 4 there was lymphorrhœa, which eventually ceased. Repair of the injured duct was performed by Keen, Cushing, Lotsch, Porter, and Gobiet, with successful results. With reference to the implantation of the divided duct into a vein, he quotes the opinion of Schopf, that the anatomical and technical difficulties are considerable, apart from the fact that it would allow entrance of blood into the duct and setting up of thrombosis. Nevertheless, the implantation of the duct into the internal jugular—a 'tour de force,' as Fredet calls it—has in one case produced a satisfactory result (Deanseley).[9]

Zesas thus mentions in his summary only 40 of the 49 cases.

Let us now, in the light of our present knowledge, examine the four methods of treatment advocated, and place them in their order of relative importance.

1. *Suture.*—This must, I think, commend itself to every surgeon where it is practicable. It is obviously the most natural method of repairing the injury, and should in consequence hold the first place. Where the injury is a slit or

tear that can be sutured, this should be done. Of the five cases reported as treated in this way, all were successful. Further, if the duct has been completely divided, and one can find both ends, this method should, I consider, be adopted.

2. *Implantation into a Vein.*—I should place this second in order of importance; it is physiologically the most rational procedure, and where suture cannot be carried out should be adopted whenever practicable.

Schopf has greatly exaggerated the difficulties, which he states to be both anatomical and technical. As regards the anatomical difficulty, this has ceased to exist in the great majority of cases. One could understand it if one had to deal with a case in which the duct entered the veins in the normal manner; but it must be remembered that in these circumstances the duct would be much more rarely injured; it is when it is abnormal in its course that it lends itself to a surgical accident. I cannot say where in each recorded case the duct was situated, but one cannot be far wrong in concluding that in the vast majority it was above the clavicle. Now here there are plenty of veins from which to select, and there is no need to implant it into a large vein like the internal jugular. I certainly made use of the external jugular in my own case, but this was because the vein had already been cut across and its severed end was lying close to the divided duct, and thus almost asking to be made use of; also, the anastomosis was made at some distance from the clavicle; but if this bone had been in the way, I should not have hesitated to divide it and turn it aside.

In regard to the technical difficulty, this must naturally depend upon the anatomical situation, and upon the skill of the surgeon. In the case I have reported there were certainly no technical difficulties; the patient was an attenuated little boy with no thickness of fat to work through, there was no trouble with bleeding, the work was done about an inch above the clavicle and not in a hole, and the actual suturing might be described as a dainty bit of surgical needlework, certainly nothing more.

Schopf[31] sets up another objection; he says this method "would allow entrance of blood into the duct and the setting up of thrombosis." This is surely imaginary! The chyle normally enters the vein and does not cause thrombosis. It is true that valves are described at the opening of the duct into the vein which would prevent a backward flow; but the tendency is for the flow to be in an onward direction, owing to the aspiration of the respiratory movements. And then, too, the mere implanting of the duct into the vein makes a valvular junction. It is true that there will probably be a small clot formed within the vein surrounding the implanted end of the duct, but this is only the natural process of repair. Some risk may be incurred, however, as a portion of it might become detached and carried into the circulation; this, in my case, I attempted to minimize by immobilizing the neck in a splint from the tenth to the seventeenth day.

3. *The Occlusion of the Divided Duct by Ligature or Forcipressure.*

We have seen that De Forest recommends the injury should be treated in the same way as a wound in a blood-vessel; but the analogy is unsound, as the thoracic duct is not a blood-vessel, but something *sui generis*. It is the connecting link between the small intestines and the venous system. It

would be equally logical to argue that the treatment should be the same as for an intestinal wound; and no one would advocate the occlusion of the divided end of the intestine.

Under what conditions would it be sound surgery to apply a ligature? Parsons and Sargent[27] have shown that in 18 out of 40 cases the duct has two terminal branches, so that ligature might be expected to be successful in nearly half the cases met with. In addition to this, there appear to be small collateral vessels which communicate with the lymphatics of the right arm and right side of the neck at their opening into the right subclavian vein. These two reasons explain the astonishing number of cures which have resulted from ligature or plugging. Would it not be well then to endeavour to ascertain whether or not a second branch existed? No surgeon would approve of the removal of a kidney unless he had satisfied himself that a second one was present. Similarly in the case of the divided thoracic duct, the careful surgeon should follow up the vessel and search for a second branch which, if found, will place the mode of treatment by ligature on a sound basis. Should there not be a second terminal branch, then all that can be hoped for by ligature is a prolonged convalescence, during which the patient will emaciate and suffer grievously from thirst.

4. *Tamponade.*—There is, lastly, the method of treatment by tamponade. This, surely, is the *dernier ressort*, and one would think only applicable where every other mode of treatment had been tried in vain, as in addition to the emaciation and thirst, there would be a more or less persistent chylorrhœa. So great an authority as Cushing, however, regards this as acting as a safety valve, preventing too great pressure in the lymph channels. One would be disposed to think that this pressure might be combated by attention to the diet, only small quantities of fatty food being allowed, until the collateral circulation was established. Meanwhile the thirst might be allayed by continuous saline infusion into the right arm or right side of the chest, and I should be disposed to make the experiment of adding a fine fatty emulsion.

This brings us to the discussion of the problem from the point of view of the physiologist. How are the three classes of foodstuffs absorbed? The sugar is taken up by the veins of the intestine and carried to the liver, and this is also most probably the course taken by the peptones, and it is difficult to see why a sufficient amount of water should not be absorbed by the same route. Thus, only the fats are left to be taken up by the lacteals and carried to the thoracic duct. Why then should the patient whose duct has been tied suffer so much from hunger and thirst? One could understand, perhaps, the removal of fat from the diet causing emaciation; still, the formation of fat in the body depends largely on the amount of carbohydrates taken, and as these are carried direct to the liver one would think that fat would still be produced. One must, however, take a broader view. The problem is not so simple as this. It must be remembered that the contents of the lymphatics of the trunk, lower limbs, and abdominal organs, at least, are prevented from escaping at their natural outlet into the blood-stream. The nutrition of all these parts might therefore well be expected to suffer from their inability to rid themselves of waste products; and it may be the liver is hampered

in its functions and unable to carry out its work of dealing with the sugar and peptones.

Then, too, the climatic environment of the patient must be considered. In cold regions a large amount of fat is required in the food to maintain the body temperature, while in the tropics practically none is needed. One would infer from this that the patient would do better in a very warm room.

The lesson to be learned from the physiologist, although the present state of our knowledge is very incomplete, is the great importance of obtaining a direct communication with the venous system, and of avoiding if possible the treatment by ligature or plugging.

CONCLUSIONS.

I should therefore advocate the following treatment of a wound of the thoracic duct :—

1. Suture the wound whenever practicable.
2. Search carefully for a second terminal branch, and if this is found apply a ligature.
3. If the duct is single, endeavour by all means to effect an implantation into a vein.
4. Ligate the duct, and trust that collateral circulation may be established.
5. Plug the wound with gauze.

In the two latter methods, if thirst is a prominent symptom, infuse saline into the right arm or chest.

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PORTUGUESE CONTEMPORARY SURGERY.

By A. H. BIZARRO.

Lisbon is the great surgical centre of Portugal, Oporto and Coimbra coming next in importance. They are all the seats of universities and of surgical clinics, and possess a mild climate which is conducive to convalescence after operations. The old phrase, *natura medicatrix*, is particularly true of Portugal, and during the winter it enjoys a very beautiful and temperate climate. There are magnificent natural situations for sanatoria, and indeed some are already to be found at different places on the sea coast. The bright sunlight is very favourable for the employment of heliotherapy,[1] and I have seen tuberculous cases treated with very satisfactory results.

There is little that is strikingly original in Portuguese surgery—English, American, French, Italian, and German authors are alike known, and it would be very difficult to state which particular school guides the Portuguese surgeons. The same man who is a passionate defender of some particular French operation will follow with equal eagerness the American method in dealing with a different surgical condition. The Portuguese, however, are good surgeons, taking great interest in their cases, and doing their very best for their patients.

In the medical libraries are many volumes by well-known British authors : Mayo Robson, Moynihan, Lane, Macewen and others. In the great libraries of the faculties and institutes are found very complete collections of international surgical papers and reviews. The libraries are really well provided with anything that is new, no matter what the country of its origin. For this reason, and because they are great travellers, the surgeons of Portugal are cosmopolitan and progressive in their technique, although perhaps somewhat lacking in originality. Some of the medical journals in the Portuguese language are : *Jornal das Sciencias Medicas*, Lisbon ; *Medecina Contemporanea*, Lisbon ; *Portugal Medico* and *Medicina Moderna*, Oporto ; *Revista da Universidade*, Coimbra ; *Archivos das Universidades*, Lisbon and Oporto ; *Boletim do Hospitale de S. Josè*. There are others besides, some of which are printed in French. There is, however, no journal dealing specially with surgery.

The Portuguese system of surgical training differs in some respects from the English. The full medical course requires six years, and is drawn up on very similar lines to that of the French. Students in their last two years of the medical curriculum have opportunities, as in France, to complete either as *externes* or *internes*. When, however, the curriculum has been completed in hospitals not connected with the universities, the men—having qualified by passing a special examination—proceed as assistants to the medical faculties, much as they do in Germany. These assistants are thus qualified men who have all passed through their practical examination, and correspond to the

English hospital surgeons who in their first five or six years are in charge of the emergency departments.

In several of the Lisbon hospitals which are not under the control of the university, the assistants stay on night and day duty twice a week. They are spoken of as Surgeons of the *Banco*, as in the old days they had the classic stool (*banco*) of Hippocrates for the reduction of dislocations as a historical detail of the furniture of the surgery. These arrangements ensure that in the large hospitals there is always an operator for any casualty that may be brought in; and Lisbon being an important town with a population of 400,000, besides the suburbs, there are always a good many cases to be dealt with surgically, especially since the reputation of the hospitals and their staffs attracts many cases from distant places. Hence it comes to pass that Lisbon holds a prominent position in connection with emergency surgery.

The Portuguese hospitals are for the most part old buildings, many being convents: for this reason the construction and dispositions of the wards and the general arrangements are somewhat imperfect. There are in Lisbon over 4,000 beds distributed amongst the different hospitals, and more than one half of these are surgical. The largest institution is S. Josè, which accommodates 700 patients. The hospitals are all under the control of the S. Josè Hospital Committee, and are supported by the state, by municipalities, and by certain private bequests.

D. Estephania's hospital for children and women is beautifully situated in the centre of an old park containing a great variety of trees, which in the spring is full of beautiful flowers; and some of the pavilions, although not of recent construction, possess large balconies. There are, however, some new buildings constructed upon quite modern principles, and at the present time others are in preparation, so that soon Portugal will have better accommodation for its surgical patients. There are also several private nursing homes, particularly at Lisbon and Oporto, which are quite complete in every way. In the male wards at the hospitals the patients are nursed by male attendants. There are several military hospitals in the most important military centres, and in the Lisbon and Oporto hospitals the eye, ear, nose and throat, and genito-urinary cases are attended in special wards by military specialists.

The Lisbon Bacteriological Institute is a modern building. The sera and vaccines employed are all made by the staff, and there is a special service directed by Athias dealing with the prophylaxis of rabies. Cases of this disease are extremely uncommon in Portugal, notwithstanding the fact that each year a great number of people are bitten by hydrophobic animals. This institute has been of much assistance to the surgery of the country: the work done is summarized and printed in French in the *Archives* which appear at irregular intervals. The bacteriological course is superintended by the Director, A. Bettencourt, one of whose assistants, N. Bettencourt, was among the earliest to introduce into Portugal the work of Sir Almroth Wright on the opsonic index, vaccines, etc.

The curriculum is a little different from the regulations of the British universities. The diploma of the general medical course is only granted after the student has submitted for the approval of the authorities a thesis, which

is advocated by the candidate and discussed by three professors who are elected by the staff of the university. The choice of the subject is left entirely to the candidate, and such theses form a most important part of the material which makes up the record of the work done at the laboratory and clinics.

In none of the universities is there any title corresponding with the British Master in Surgery, which is quite a characteristic feature of the broad surgical education given in the British colleges and universities. The fees amount to from £10 to £14 per year, including the practical courses, and the diploma costs £15. The full medical course, including the preparatory studies —elementary, primary, and secondary (Lyceum)—means eighteen years of

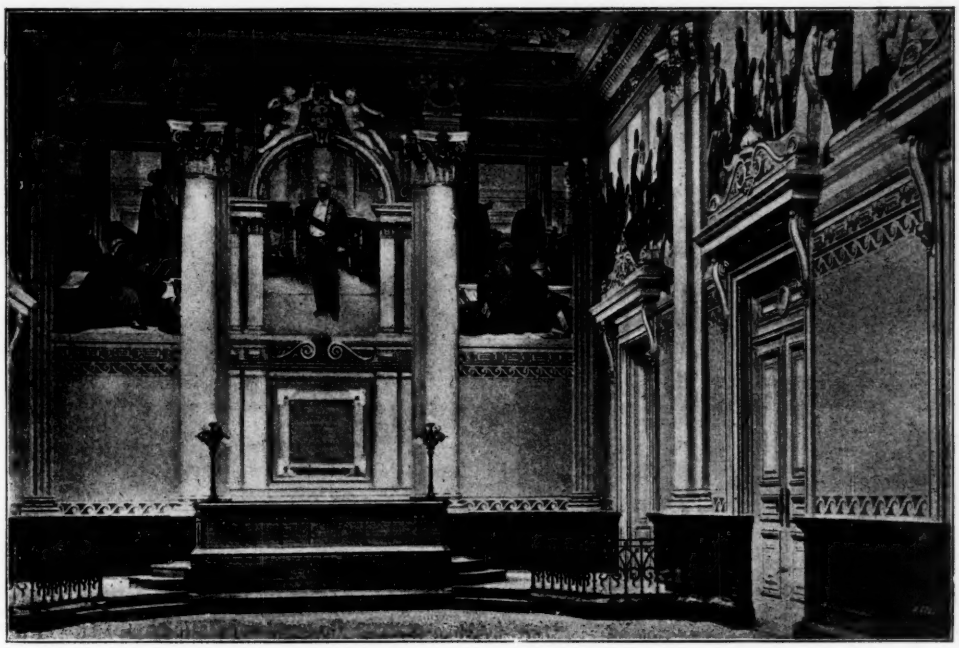

FIG. 208.—'Thesis Room' of the Lisbon Medical Faculty.

education, and as a rule the age of the students who have passed their final medical examinations is from 24 to 26 years.

There is no special medical school for women, which is not surprising in view of the fact that the inhabitants of Portugal number only six million, or less than the population of London. The profession on the whole is as much overcrowded in Portugal as in other countries.

It would be invidious to attempt a detailed account of the hospitals. There is room for improvement. Some of the wards are too large, accommodating over 80 patients. The new buildings, however, are constructed upon more modern lines, and have smaller wards, which never contain more than 30 beds. Each ward has an operating theatre close at hand; but rarely is an anæsthetic room to be found. In the newer institutions many up-to-date improvements are installed, and as a whole there is evidence proving that

the Portuguese mind is not inaccessible to progressive ideas of foreign origin. The majority of the hospitals have a past of some historical interest. The reader who knows the organization of some of the hospitals in central France, and those of the northern provinces of Spain, will find a great similarity between them and the old hospitals of Portugal. For this fact there is of course an ethnical explanation. The hospitals are mostly connected with the medical schools.

The arrangements for emergency service at the S. Josè Hospital are modern and quite extensive. There is at Lisbon a hospital for diseases of the eye, where Gama Pinto is to be found. The *x*-ray department in the same city is under the charge of Castro, and his work is really excellent. At the hospital of S. Martha there is a laboratory for each ward, and a central one at the S. Josè.

It does not seem fitting to close these introductory remarks without referring to John Hunter, who was in Portugal as an army surgeon with the British contingents that fought so many battles and won imperishable renown on Portuguese soil.

Asepsis.—The Portuguese are very keen in the practice of aseptic surgery. It is usual in some clinics for the surgeon to have one assistant only while operating. The sutures are prepared by the operator himself and then covered with gauze to be ready at hand. The sterilization of instruments, gowns, gauze, sutures, and gloves is done either in dry sterilizers or else in boiled water containing soda carbonate in solution in order to raise the boiling point. Either American or French gloves (chaput type) are worn, and most surgeons wear a mask of some kind. Pagenstecher's thread is frequently employed instead of silk, and the catgut used is supplied in glass tubes ready sterilized by foreign makers. The majority of surgeons and their assistants brush the hands with soap and water, followed by spirit and some antiseptic (oxycyanide of mercury, etc.). Some, however, are content to rub the hands with a swab soaked in alcohol or alcohol-acetone, without previous scrubbing with soap and water. Patients are as a rule shaved the day preceding the operation, and the skin is painted with a 5 per cent alcoholic solution of iodine. In some clinics the skin is previously rubbed with spirit or turpentine, and then freely painted with iodine immediately before operation. Michel clips are used commonly for the cutaneous sutures.

Anæsthesia.—To-day ether is the most common anæsthetic given in Portugal. The majority of Portuguese surgeons (Santos[2]) are great enthusiasts for ether, and chloroform is very seldom used for their patients. Santos, arguing mostly from the action of chloroform on the liver, heart, blood, kidney, etc., considers it extremely dangerous when it is excreted by the system. Occasionally spinal, regional, and local anæsthesia (cocaine, novocain, adrenalin, eucaine, etc.) are employed. Ether or chloroform is usually given by the open method, although in some clinics inhalers of several types are to be found. For head and face operations ether is frequently given by the rectum or intratracheally (Meltzer), and sometimes intravenously in bad cases. Crile's anoci-association has been specially studied by P. Coelho.

In some clinics morphia and pantopon are always injected, thirty minutes as a rule before the beginning of the anæsthesia. Every member of the medical staff is expected to be competent to administer anæsthetics, as no specialists are appointed for the work. In some hospitals the arterial pressure is taken during the progress of the operation. Some idea of the recent advance in the administration of anæsthesia in Portugal is to be found in the numerous theses which have been written during the last ten years by the students. Ethyl chloride and gas are very seldom employed.

In some clinics Schiassi's solution (glucose and magnesium and sodium chlorides) is commonly injected instead of the ordinary saline.

Surgery of the Nervous System.—*Head operations* are mostly called for on account of injuries and gunshot wounds; there are, however, numerous cases of new growths and abscesses[3] which have been dealt with surgically and most successfully. The instruments commonly used are Doyen's trephining set, and the details of technique are those followed by Doyen, Horsley, Cushing, and Krause. Cranial operations are as a rule performed in one stage. Craniectomies for the removal of new growths are done occasionally. I have seen a case of round-celled sarcoma of the motor region operated upon by Gentil, and he has among his statistics a good case of a tumour of the eighth nerve that is well worthy of reference. De Martel's trephining and Kredel's plates are used in his clinic. In hydrocephalus, repeated lumbar punctures have achieved remarkable results, even though blindness is one of its complications (Salazar, Lage).

Spinal cord injuries are not very uncommon, and good results have been accomplished by laminectomies and the reduction of the dislocated vertebræ (Vasconcellos). Some of the instruments used for this purpose were made under the direction of Raposo. Some cases of spinal new growth have been dealt with surgically (Santos) with fair results.

Several cases of *Little's disease* have given opportunities for the trial of rhizotomy. Salazar, however, is not much in favour of this operation unless tenotomies and reductions should fail.

Injuries and new growths of the nerves are frequently operated upon, and I was told of some successful cases. In one patient, the removal of six inches of the great sciatic nerve and the transplantation of a piece of the small sciatic was done in a case of new growth; the operation was performed four years ago, and in spite of some sensory trouble and difficulty in the extension of the foot, the patient walks steadily (Cabeça).

Alimentary Canal and Abdominal Surgery.—The surgery of the digestive tract is quite modern. Radioscopy and radiography are always most carefully done, and the help thus afforded is highly valued.

Foreign bodies in the upper part of the digestive tract are removed by means of œsophagoscopy, and only very seldom by an œsophagotomy (Gentil, Santos, Almeida, Mello, Castro, McBride[4]). If the foreign body is impermeable to the *x* rays, the duct is *x*-rayed and the body then removed with the aid of the screen by means of a special forceps (Castro).[5]

New growths of the tongue are dealt with especially by the Kocher and Morestin technique.

Gastric and duodenal ulcers that have perforated are somewhat common among the casualties of the emergency department. The technique of Roux, Moynihan, Mayo, Meyer, and Bier is widely known, and gastrojejunostomies are now performed by the posterior methods only. Cabeça has tried every plan since the anterior method of Wölfler, but for the last four years the Mayo technique has been the method of his choice; one case, however, which he operated upon fourteen years ago by Wölfler's anterior method, is still doing well. Posterior gastrojejunostomy with pyloric exclusion is usually performed if the general condition of the patient is fair (Gentil).

Although patients with *gastric neoplasms* generally seek surgical aid at a late period, nevertheless several gastrectomies have been performed (Vasconcellos, Cabeça, Gentil), and some of these patients have been operated upon over ten years ago without any recurrence.

Duodenostasis has been found as a result of Lane's first kink (Paes). Meckel's diverticulum and Jackson's membrane occur with the ordinary frequency, and give rise to classic complications.

Appendicitis cases are operated upon in the first forty-eight hours, and MacBurney and Battle's method is popular. For laparotomies in the iliac fossæ the MacBurney technique is usually employed, and whenever necessary the transverse incision is enlarged right up to the rectus sheath, which gives sufficient room for the removal of the ileocæcal junction (Gentil).

For the removal of *malignant growths of the rectum*, the perineal route is usually selected, with or without removal of the coccyx.

Piles are commonly dealt with by the ordinary methods—Whitehead's, the cautery, etc.

In *abdominal perforations and injuries* early operation is the rule (McBride, Santos,[6] Gomes, Coelho, Yorge, and Gentil[7]). Santos[8] has pointed out that any acute hæmorrhagic abdominal effusion may give rise to the classic symptoms of perforation. The use of camphorated oil (5 to 10 per cent) is a routine practice; restricted drainage, salines per rectum, sitting up in bed, and oxygen, are some of the details for the treatment of sepsis due to peritoneal absorption. The frequent washing out of the stomach, and injections of hormonal, pituitrin, and atropine, are usually prescribed in alarming cases of paresis. Washing out the peritoneum is employed whenever there are bowel contents in the abdominal cavity.

Septicæmia resulting from ordinary surgical conditions is commonly treated by means of the fixation abscess. This is easily obtained by injecting 1 to 2 c.c. of turpentine into the areolar tissue of the outer side of the thigh in the interval between the tensor fasciæ latæ and the skin.

Operations on the liver and bile-ducts are common, injuries to this viscus being rather frequent; hydatid disease is also well known. Sometimes the latter condition is dealt with by opening the cavity through the pleura and diaphragm and superior surface of the liver, although the abdominal route is the usual one.

Successful cases of *pancreatic surgery* are recorded in the hospital statistics. The surgery of the gall-bladder and ducts, and of the pancreas, has greatly improved since Mayo Robson's and Moynihan's classic work on the subject became known. I have seen cholecysto-gastrostomies per-

formed in cases of gall-stones and secondary pancreatitis, and the results gained have been quite satisfactory (Gentil, Santos).

Splenectomies have been performed for injuries, movable spleen, malarial splenomegaly, and Banti's disease, with very satisfactory results (Cabeça, Gentil, Paes).

Transverse abdominal incisions are now in general use.

Hernia.—Knowing beforehand the high percentage of hernia among the Portuguese, one would expect to find many cases in the clinics and emergency services, and as a matter of fact there is an extensive practice in this department of surgery. For inguinal herniæ, the methods of treatment followed are those of Bassini, Kocher, or the Mayos. Femoral herniæ are operated upon usually through an incision below Poupart's ligament; a few, however, are done above this position. Umbilical herniæ are dealt with by the Mayo method. When this condition occurs in children, it is first treated by means of the classic strapping covering up the hernia and stretching the skin towards the umbilicus. If this method fails, or if the child is not seen until too late, then Notta's operation is now being a good deal tried (Lage). Inguinal hernia in children is from the very first treated with a woollen truss, such as was formerly used in the United States.

Surgery of the Thorax.—This has received much attention in recent years.

In removing *new growths of the breast*, Halsted's and Handley's technique is mostly followed, but in some places the visitor will meet with modifications of these fundamental methods.

In *lung disease*, some cases are reported (Cabeça, Gentil) of resection of several ribs for pulmonary gangrene. In cases of tubercle and emphysema of the lungs, resection of the costal cartilages (Freund) has been practised. McBride is in favour of the drainage and permanent suction through the rib itself of some pleural effusions by means of a tube through a trephine hole made in the bone. Artificial pneumothorax is usually done for cases of pulmonary tubercle.

Cardiac surgery.—Gentil has made this work especially his own. Since 1905 he has favoured an exploratory thoracotomy made through the fifth left intercostal space, removing the fifth rib by cutting its cartilage.[9, 10, 11] He has performed three cardiorrhaphies, and one patient—a man stabbed through the right auricle twelve years ago—is still living and carrying on the work of a cabman. Gentil was the first surgeon in Portugal to perform a pericardotomy. It was a case of pneumococcal pericarditis, and a speedy recovery and very satisfactory result followed.

Ligature of the large blood-vessels for the arrest of hæmorrhage and in cases of aneurysm, vascular suture, and transfusion of blood (Santos) have been occasionally practised with excellent results.[12, 13, 14]

Genito-Urinary Surgery.—There are specialized surgeons in urology in Portugal, though some cases are operated upon by general surgeons. In the university surgical clinics, the genito-urinary specialist is usually called in for diagnostic purposes. Thus, at the first clinic of the Lisbon faculty, Gentil

has Gomes as an assistant urologist, and in the second clinic Cabeça is helped by Pereira for the same purpose.

The commonest condition of all is *gonorrhœa* and its complications. At the Desterro Hospital there are special out-patient departments for this disease. Strictures are gradually dilated and meatotomies (Baer's method) are frequently carried out. Internal urethrotomies are very seldom performed in hospital patients, as they require a very long treatment. The instrument used is the Maisonneuve-Nicolich urethrotome.

As a rule traumatic *urethral ruptures*, *urethro-perineal fistulæ*, *etc.*, are treated by means of an incomplete urethrectomy, followed by a circular urethrorrhaphy, and the urine is drained through a suprapubic cystotomy or a urethrostomy—Marion's method. This procedure avoids irritation of the scar by the catheter, and thus lessens the risk of a further stricture.

Prostatectomy is performed by Freyer's technique. The cystotomy operation is done under local anæsthesia. As at St. Peter's Hospital in London, the operation is in bad cases performed in two stages. For the removal of the prostate itself, either local, spinal, or in a few cases general, anæsthesia is adopted.

Litholapaxy is practised, and excision of vesical polypi and the removal of foreign bodies with the aid of *cystoscopy* are keenly advocated (Santos, Ravara[15]).

Some cases of *extrophy of the bladder* have been dealt with by means of a uretero-rectal anastomosis, not without some success (Salazar, Monjardino[16]).

Renal Surgery.—Guyon's and Edebohls' incisions are commonly used for approach to the kidney and ureteric regions (Gentil[17]), the former for cases of stone, tuberculosis, and new growths, and the latter for movable kidney. Posterior pyelotomies are usually performed for the removal of stone, and in cases where difficulty is experienced in delivering the kidney, and where the stone is abnormal in size and shape, a nephrotomy is carried out.

The methods of Edebohls and Ruggi in a modified form are used for fixation of the kidney in cases of ptosis. The capsule is cut into four separate flaps, which are stitched to the surrounding structures, above and below the eleventh and twelfth ribs. The ureter is most carefully dissected out and taken away in any nephrectomy for tuberculosis.

The latest methods of exploration are employed. An operation is always preceded by a careful study of the functional activity of either kidney by means of chromocystoscopy with carmin of indigo (Voelker), the co-efficient of Ambard, experimental polyuria (Albarran), and previous catheterization of the ureters. If necessary, the phloridzin test (Carper) and cryoscopy of the separated urines may be employed as well. Pyelography has been well known for many years, with acknowledged practical advantages.

Ravara, Bastos, and Santos have all special clinics, where visitors can observe the practices and technique of these surgeons in urologic cases.

Surgery of the Bones and Joints.—Here the chief stimulus has been the classic work of Farabœuf. Apart from this, Kocher's technique is commonly followed.

Amputations in aseptic cases have been performed after Bunge's technique (Cabeça). The bone is freely denuded of its periosteum, and the bone-marrow removed at the cut end. This method gives good stumps for the artificial limb.

Bony new growths are commonly removed if well covered by a capsule, and several consequent *transplantations* have been made. The first operation of this kind was performed in 1906 by Gentil.[18, 19, 20] It was a case of sarcoma of the tibia, and having removed the whole shaft, the fibula was then transplanted into its place. This case did well, and at the present time the *x* rays demonstrate a normal development of the bone.

Fractures.—In open fractures, the great advantages of the earliest possible operation have been recognized. The removal of dead fragments, hæmostasis, and free drainage, are performed immediately after the admission of the patient. Astragalectomy is considered an advantage in wounds of the ankle-joint. It ensures a better drainage than any other proceeding. Anti-tetanic serum is always injected in these cases, and the injection of sodium nucleinate and electrargol is recommended in some clinics as a prophylactic treatment against the ordinary septic agents.

The treatment of fractures, as a whole, is on the usual lines followed in other countries. The reduction of some fractures is done under a general anæsthetic with concomitant *x*-ray examination (Paes[21]). The classic work of Lucas-Championnière, apparatus of the Hennequin, Cotton, and Scudder type, and the work of Bardenheuer, are all well known, and furnish additional evidence of the eclecticism of the Portuguese.

As regards operative treatment, patella fractures are always operated upon, as are also the more uncommon olecranon fractures. Where non-operative methods fail to produce a good result, or if the fracture is of a bad type, Portuguese surgeons do not hesitate to operate. Lambotte's and Tuffier's methods are quite familiar, but Lane's technique and instruments are nowadays preferred by the Portuguese. Gentil advocates dealing with fractures of the tibia by means of Dujarier's clips.

Tuberculous abscesses are in the great majority of cases treated by aspiration and injection of iodoform, etc., by *x* rays, immobilization, and heliotherapy.

New Growths.—Radium has proved itself of some value. Gentil gives one case, for example, of an inoperable small round-celled sarcoma of the parotid gland treated nearly two years ago without any recurrence. *X*-ray treatment is systematically adopted after operation. According to Gentil, the colloidal metals have been tried and pronounced a failure.

Stress is laid upon early diagnosis, a thorough knowledge of all precancerous conditions, and operative treatment wherever anatomically possible. The operation is performed by cutting down through healthy tissues, and the wound is covered at once by means of some plastic operation. *X*-ray treatment must be advised and carried out whenever the tumour shows histological or clinical signs of malignancy.

Electrocoagulation has been tried and has achieved only fair results. Electrofulguration treatment has proved to be of use only for the arresting of hæmorrhage from ulcerated growths (Gentil).

Thyroid Gland Surgery.—Every surgical method appears to have been tried thoroughly. Statistics show many cases of Jaboulay's operation, ligature of arteries, thyroidectomies, etc. Kocher's and Mayo's work on the subject is well known in Portugal.

Rebello[22] has worked out the effects of thyrotoxic serum injections, and in some cases has achieved good results.

Lately the *x* rays have proved of some value in treating cases of thyroid hyperactivity.

In conclusion, I will refer shortly to some of the clinics. The S. Martha Hospital is the official teaching institution of the Lisbon medical faculty. Cabeça is the professor at the second surgical clinic, and has under his charge four wards of 25 patients each for both sexes. Both general and local anæsthesia are employed. Morphia is always injected thirty minutes before beginning the anæsthesia. Operations for hernia, castrations, exploratory laparotomies, gastro-jejunostomies, and the removal of cutaneous and certain muscular and mammary new growths are all undertaken under local anæsthesia following Braun's method. For mouth operations ether is given by the rectum. Cabeça, who is a very good operator and a keen technician, has one assistant only while operating.

Gentil is in charge of the first surgical clinic, and has the same number of beds. The cases are grouped under septic and aseptic, and any patient before being anæsthetized has his blood and blood-tension carefully studied. Spinal anæsthesia is frequently employed, the solution preferred being the acidified stovaine-adrenalin mixture.[23] Chloroform is given by means of Ricard's mask. Ether is most commonly used, and is given either intravenously, by the rectum (Meltzer), or more frequently by inhalation by means of Ombredanne's apparatus. A hypodermic of pantopon is injected some little time before the beginning of the operation. The skin is sterilized by painting with iodo-borax solution (iodo-borax, 5 vols.; chloroform, ether, and alcohol, 10 vols.). Gentil is a careful surgeon, a good organizer, and a master of his work.

Feijao is the senior surgeon of the faculty, and with Santos has the direction of the teaching of surgical therapeutics. They are most enthusiastic, and Santos, as already mentioned, is a noteworthy urologist.

The teaching of orthopædics is undertaken by Professor Salazar at the Estephania Hospital. Hare lips are usually operated upon when the child is a year old, and cleft palates after the third year. In the same hospital the visitor will find Monjardino, who is also Professor of Surgery. In their own branches both are remarkable men.

At the S. José Hospital is the clinic of Vasconcellos, who is on the staff of the faculty; during his absence abroad the work is under the direction of Paes.

Finally, my thanks are due to many Portuguese surgeons for their courteous help in supplying me with materials for this paper.

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SHORT NOTES OF RARE OR OBSCURE CASES.

A CASE OF SPONTANEOUS RUPTURE OF THE URINARY BLADDER.

By Lieut.-Colonel SINCLAIR WHITE, R.A.M.C. (T.)
AND
Captain N. J. WIGRAM, R.A.M.C. (T.)

The particulars of the following case are of interest; it is an example of perforation from ulceration of a non-specific character—a very rare condition :—

Pte. J. O. was wounded on Jan. 4, 1916, by a fragment of high explosive shell which penetrated his back. He was admitted to the 3rd Northern General Hospital on Jan. 12.

On Admission.—There was a small wound of the back on the level of the 11th dorsal spine. There was complete paralysis, loss of sensation, and loss of reflexes corresponding with a complete transverse lesion of the cord at the level of the last dorsal segment. There was retention, with false incontinence of urine. There was marked cystitis, and the urine contained a large amount of pus and blood. The skiagram shows a foreign body at the level of the 2nd lumbar spine.

The condition continued much the same up to March 15. The cystitis showed no signs of improvement, in spite of treatment with drugs and regular bladder washings. But on this date, about three hours after the bladder had been washed out, he was suddenly seized with acute abdominal pain, particularly marked in the hypogastrium.

On examination, he was found to be suffering from severe shock, and looked very blanched. The pulse was 130, temperature 97·2°. The lower part of the abdomen was not moving on respiration, and there was tenderness and marked rigidity in the hypogastrium. The scrotum was swollen and œdematous.

A soft rubber catheter was passed into the bladder, and a little blood-stained urine evacuated. A pint of boracic lotion was then run in, but only eight ounces were returned. The scrotal swelling was slowly increasing.

Operation.—Within an hour of the onset of the symptoms a central suprapubic incision was made under general anæsthesia. Several ounces of blood-stained fluid escaped from the extraperitoneal tissues. The bladder was then opened by incising the extraperitoneal portion, and palpated from

within. On the anterior wall, just to the right of the middle line, there was a small ulcer which admitted the tip of the index finger. This had perforated through all the coats of the bladder. A drainage tube was put into the bladder, and the rest of the incision closed. Multiple incisions were made into the scrotum and on either side of the pubes.

The cystitis quickly improved, and at the end of a fortnight had cleared up entirely. The suprapubic tube was then removed and the wound quickly closed. The general condition has remained good, but the paralysis and anæsthesia have remained the same.

The favourable progress of the cystitis subsequent to suprapubic drainage suggests that this procedure might be advantageously resorted to as a routine practice in the treatment of severe bladder inflammation following spinal injury.

CASE OF A WOUND OF THE PORTAL VEIN: OPERATION: DEATH NINE DAYS LATER.

By Lieutenant W. H. C. ROMANIS, R.A.M.C. (T.C.).

The following case of a shell wound of the abdomen which was treated in a casualty clearing station may be of interest on account of the actual injuries caused, and also as an instance of a shell fragment passing through the abdomen from front to back without injuring any portion of the intestinal canal.

An Australian soldier was wounded by a high explosive shell at 4 a.m. on July 5, the fragment entering just below the left costal margin, one inch to the left of the ensiform cartilage, and not leaving the body. When first seen, late the same evening, the patient's condition was bad: he was pale and cold, with a thready pulse of 120; vomiting was marked, and the abdomen was very rigid all over, tenderness being especially felt in the epigastric region. Under chloroform a laparotomy was performed through the left rectus at 3 a.m. on July 6, twenty-three hours after the receipt of the wound, and the abdomen was found to contain a large amount of fresh blood. A track was traced down and to the right, through the left lobe of the liver, emerging on its under surface, passing through the lesser omentum, and tearing a lateral hole about half an inch long in the portal vein, from which blood was gushing freely. A plug was placed in the liver wound and two artery forceps were clamped on the side of the vein in a longitudinal direction; these controlled the hæmorrhage. The track of the missile was then seen to pass on just to the outer side of the second part of the duodenum, and to pierce the peritoneum of the posterior abdominal wall here. Owing to the condition of the patient the fragment was followed no further, and a rapid examination of the stomach, small intestine, and transverse colon discovered no perforation. The blood was then mopped out and the wound closed in three layers in the usual way, the plug and the artery forceps being left *in situ* with their handles emerging from the upper end of the incision, half an inch of which was left unsutured

for that purpose. Next day the patient was much better, with no vomiting, and he continued to improve for several days—the plug was removed on the second day, and the artery forceps taken off on the third day without any difficulty. Improvement continued until the eighth day, when the patient was doing well and eating solid food, his bowels being opened naturally each day. On the evening of the eighth day, however, he suddenly complained of severe hypogastric pain, vomited twice, and passed some urine with much blood in it. His abdomen remained quite soft and mobile, but his pulse failed and he died in an hour.

Port-mortem Examination.—There were found no peritonitis, no adhesions, and no perforation of the intestinal tract. The lumen of the portal vein was patent, the wound in it being represented by a sound scar, and the liver substance appeared quite normal. A large retroperitoneal hæmorrhage was present round the right kidney, and on dissecting out the right renal artery, an ulcerated hole half an inch long was found on its posterior aspect, close to which there lay a small jagged piece of shell case, a little larger than a green pea: thus the patient died on the eighth day apparently of secondary hæmorrhage from the renal artery.

Several other instances have been recorded in the present war of cases in which artery forceps have been temporarily left on the large veins of the abdomen, and the above case is only published as one of an uncommon class.

In Memoriam.

SIR VICTOR HORSLEY, C.B.,

M.B., B.S. (London), F.R.C.S. (England), F.R.S.
Consulting Surgeon University College Hospital;
Surgeon National Hospital for Paralysed and Epileptic;
Colonel, Army Medical Service.

Sir Victor Horsley died at Amara, on the Tigris, on July 16, in his fifty-ninth year. He had served his country during the present war in France, Egypt, Gallipoli, and Mesopotamia, and he died after an illness of scarcely more than twenty-four hours, which attacked him in the midst of activities characteristically unselfish and strenuous.

Up to the onset of his last illness the gifts which had made him the pioneer of surgical neurology thirty years before, and had kept for him the admitted primacy in that department throughout the world, were unmarked by any sign of declension. He had always so dreaded the hardening and narrowing effects of age, he had always so retained the mental buoyancy and physical vigour of youth, that it was impossible for anyone who knew him well to imagine him becoming an old man. The mind refused to picture him, after whatever lapse of time, enclosed within the shrinking horizons of old age, and able no longer in his characteristic way to treat his bodily strength as inexhaustible by demands however prodigal. Fate has made such intuitions seem almost to have been forebodings, by taking him from the service of science and of his country while his powers stood at the very zenith of their long and brilliant course.

The eighth and ninth decades of the last century indicate in a rough way a period of great significance for medical science. It was a period of immense expansion in experimental physiology and pathology, and it saw the foundation of modern surgery by the liberation of operative technique from the fetters imposed by the fear of infection. Both these developments were going on during Horsley's student years, and they provided an atmosphere ideally suited to his ardent and enterprising mind. Infinite possibilities were opening up before the experimental physiologist and the practical surgeon. It was Horsley's good fortune to be equally interested and equally capable in both these fields of promise; it was his unique distinction to cultivate them both with equal success and equal persistence. He thus began his career in the practice of a principle to which he remained steadfastly loyal to the end—the conception that experimental research is essential to the progressive study of surgery. His devotion to experimental science never showed the least tendency to decay into a mere pious opinion, as it is so apt to do

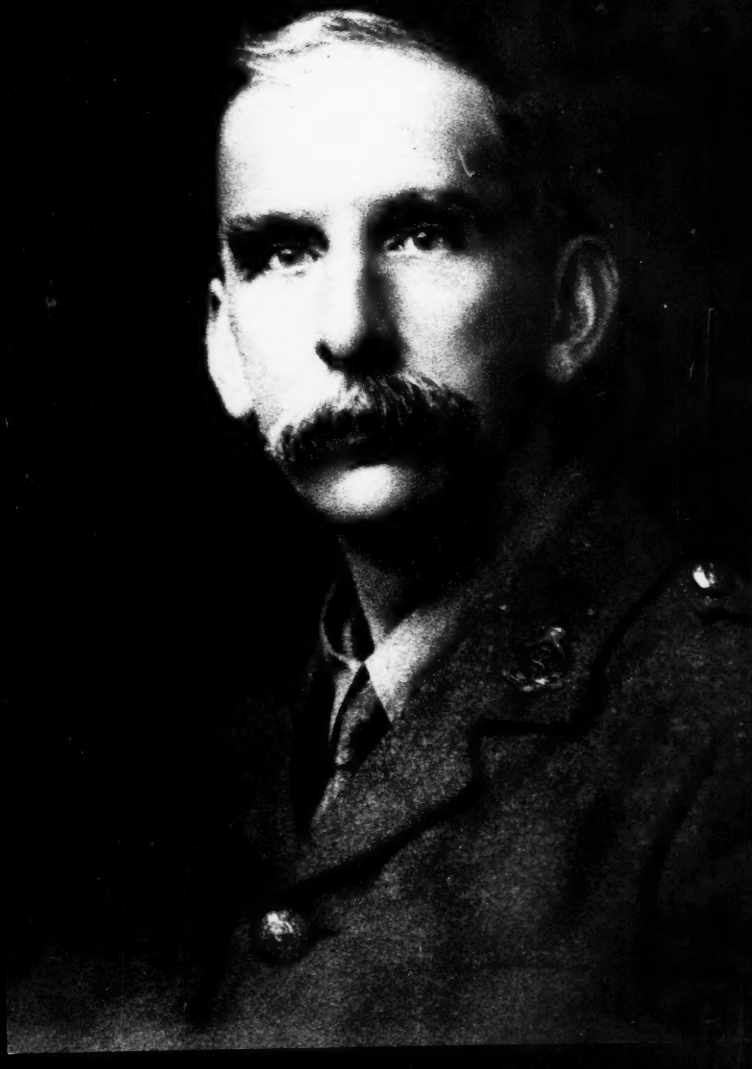
under the accumulation of other activities, but was demonstrated by the continuous use of his great gifts as an experimenter and by an output of published material which, prodigious as it was, probably embodied a comparatively small proportion of the actual laboratory work he carried out. Year after year certain hours of the week were regularly set aside for the laboratory, and all who were associated with him soon learnt that these hours were to be regarded as the most serious of his engagements and the least liable to be set aside by other calls. When the immense range of other matters in which he was deeply interested is considered, it is possible to get some idea of the strength in him of this master passion for science, and the fortitude of the will which could maintain it against encroachment through more than thirty multitudinously crowded years.

Of all that was accomplished in that time no complete account is now, or perhaps ever will be, recoverable. Horsley was always infinitely more interested in the carrying out of his researches than in the record and publication of them, and he often shrank from labours of the latter kind when he had been unstinting of time and energy in the work itself. Thus there can be no doubt that his untimely death has left unformulated, and therefore lost to the world, many a product of his tireless hand and brain. But even so, how immense is the record he has left of actually completed work, work, moreover, which is no longer dependent for survival on the already classical papers in which it was announced, but is embodied in the very structure and substance of medicine and surgery as they are everywhere practised to-day.

Most of his experimental work was of course concerned with the nervous system, where his skill as an operator was of such incomparable value. In his earlier years, however, he was no less active and successful in other fields. Such, for example, were his researches in rabies, to which in their degree we owe the impulse which has stamped out that disease here, and his studies in the pathology of the thyroid body, which finally demonstrated the causation of myxœdema and led him to suggest the therapeutic use of thyroid grafting.

His researches in relation to the nervous system may be roughly grouped into those concerned with the effects of traumatic lesions, and those dealing with what may in a very broad way be called localization.

In the first group are to be found some of the earliest attempts to investigate by precise methods the physics and physiology of the cerebral circulation—matters which had been a province from time immemorial blighted by mystic doctrines and *a priori* dogmatism. This led up to the study of experimental bullet wounds in general. These were matters into which he threw his utmost energy and gusto. As a sportsman and Volunteer he was always interested in problems concerned with firearms, and he brought his practical knowledge and skill to bear with great effect upon the subject of research. As is well known, his interest in the theory of bullet wounds lasted throughout his life, and he carried out further experiments in the subject, on which his authority was generally recognized, in quite recent years. We owe to him more than to anyone else the recognition of the importance of the mere velocity of bullets—quite apart from deflection and deformation—in the production of their explosive effects.



The group of researches included under the general heading of localization comprise, perhaps, the great bulk of his work. Among them were elaborate and minute inquiries into the distribution of function in the cortex and the conducting tracts of the brain, carried out in the very early days of such study, and now classics in the history of physiology; and of late years a similarly exhaustive and detailed examination of the cerebellum by a special method of investigation which was designed to produce lesions of any size in any given part of the organ.

Other researches, such as those devoted to the conducting tracts of the spinal cord, the pathology of epilepsy, and the functions of the pituitary body, need be no more than mentioned.

Almost all his laboratory work was done by Horsley in collaboration with others—with Beevor, for example, upon the cerebral cortex and tracts, with Gotch upon the spinal cord, and with various eminent living physiologists. Apart, however, from such distinguished collaborators, he worked at various times with a long succession of students who had been attracted to his laboratory from all parts of the world. With such it sometimes seemed that he was perfectly contented if they contributed nothing but enthusiasm to the common task, and he would put his unrivalled operative skill and the resources of his laboratory at anyone's disposal, having plainly no other object whatever but the encouragement of research and the progress of knowledge.

Great as he was as an experimentalist, there can be no doubt that it was in surgery that his powers found their fullest scope. Endowed with every aptitude of the surgeon, and trained by his already extensive experience in the laboratory, he was led by a happy conjunction of events to attack the one great province of the body which had so far been practically unexplored by surgery. Within a few intensely busy years he had established the surgery of the central nervous system upon a firm basis; he had laid down the broad lines of a safe and satisfactory operative technique; and he had produced examples of successful work in the new field which gave him at once a European reputation and a position of classical authority. It is interesting to recall how rapidly and at how early an age these conquests were made. In 1885, at the age of twenty-eight, he was appointed Assistant Surgeon to University College Hospital; in 1886 he was appointed Surgeon to the National Hospital, Queen Square, and did his first successful operation for cerebral tumour; in 1887 he devised and carried out for the first time the operation of laminectomy for spinal tumour; in 1890, at the age of thirty-three, he contributed to the International Medical Congress at Berlin an account of his experience in the surgery of the nervous system which made it plain to the recognition of all that surgery had annexed a new and fruitful province. The surgery of tumours of the brain and spinal cord continued to engage his interest and his efforts throughout his life; but there were few other conditions of the nervous system, where surgery could be regarded as offering any possibilities, which he did not attempt to deal with. In tuberculosis of the spine, in the various forms of cerebral and spinal meningitis, in the treatment of neuralgia, he devised and carried out various forms of

operative treatment, often with the most gratifying success. The treatment of neuralgia was a matter in which his intense sympathy with suffering made him a determined and tireless worker. Long before any general attention was given to the value of posterior root section for pain, he had carried out the operation repeatedly and with complete success. The problem of trigeminal neuralgia—still perhaps not altogether solved—was attacked by him with endless thought and skill. So long as twenty-five years ago he designed and carried out the intradural division of the nerve. The operation —one of the most formidable there is—was unsuccessful, and attention was distracted from the method by the various operations for removal of the ganglion. He returned to it, however, in later years in certain cases where the ganglion operation had failed, and often carried it out with complete success. It is characteristic of the man that his first attempt should have evolved the most radical measure—possibly the only absolutely radical one—and the only one which is theoretically unobjectionable. He practised in turn the removal of the ganglion by the zygomatic and the temporal routes. The latter operation he did far more often and with greater success than any other operator, and gave to the procedure a currency it would probably not otherwise have had. When the method of the injection of alcohol was introduced he did not fail to make himself familiar with it and to use it, in spite of his temperamental inclination to more radical measures. The Hartley-Krause operation was always one which displayed his surgical gifts in the most impressive way. He was frequently called to undertake cases in which others had failed to remove the ganglion, and he would find his way through the tenfold difficulties of such operations with inimitable address and patience.

It was characteristic of all Horsley's work on the nervous system that he was a deeply adept neurologist as well as a surgeon. This combination —just as the combination of experimental science and surgery which he also embodied—contributed much to the confidence, precision, and resource which were so conspicuous in his operations.

In attempting to get a true conception of the man, it is important to remember that throughout his career Horsley continued to be interested in the whole field of general surgery, and brought to the teaching and practice of it a freshness and an individuality which had a remarkably stimulating effect upon those who were brought under his influence at University College Hospital. His temperament and operative skill made him an ideal exponent of the modern methods of dealing with malignant disease. In cases of malignancy in the mouth or of the breast, for example, he was an early and determined practitioner of the type of operation which is deliberate, precise, and based upon pathological knowledge, and has replaced the older and merely 'amputational' procedures.

He never gave much time to clinical teaching. It would be easy to assume that this was because he was always so immensely busy, or because he disliked a task that is found by some to be tedious. To those who knew him well, however, it was quite plain that his deep personal modesty and simplicity would not allow him to believe that any given student was ignorant

of the elements of his subject. Such ward teaching as he did was therefore always apt to be given by him the appearance of a consultation in which perhaps the junior dresser would be asked to compare notes with the surgeon on some intricate cerebral lesion. Little as he did of formal teaching, his influence upon the whole surgical tone of his Medical School was profound. Every word and act of his displayed his passion for progress and enlightenment, his confidence in the future, and his respect and tenderness for the young as the fathers of it. No student ever went to him for help and encouragement without coming away inspired by his own spirit of optimism, his thoroughly practical advice, and his real and ready interest.

After his resignation from the active staff, his services as a consultant were always freely available and were often used. Never was his captivating personality seen to more advantage than on these occasions. He would give the fullest measure of time and trouble to the examination of the case, and would enrich his discussion of it from the prodigious store of clinical experience which now, alas, is almost wholly lost to the world. No one who has benefited from his genial wisdom, his easy mastery on occasions such as this, can ever forget them or cease to mourn that they will never be renewed.

It has been remarked of men of science that there is apt to be a disappointing contrast between the significance of the work they do and their equipment of personality as individuals. No such anticlimax was in store for those who came into contact with Horsley. Great as his work was, the quality of the man was yet more impressive. His was a personality that could make itself felt in any company, though he never made any attempt to impose himself, and was entirely free from the slightest affectation of superiority or the reserve which his great position and prestige might perhaps have justified. To his patients his easy, simple, kindly manner, his tender humanity, and his inexhaustible consideration, must often have provided a surprise for their expectations; they certainly won complete trust and devotion.

The total impression of the man was at all times one of easy and generous power. However much he might be engaged with scientific and surgical concerns, his abounding vitality left him energy to give a lifetime to medical politics and a deep devotion to the interests of his profession; left him time to enjoy and cultivate art, literature, history, and archæology; and finally—as if these interests were not enough—left him the energy to throw himself into public affairs with the vigour of a man who had no other task and with a single-hearted passion for the betterment of his race.

ON THE REGENERATION OF BONE IN ITS RELATION TO THE CULTIVATION OF BONE TISSUE.

By N. A. DOBROWOLSKAJA, Petrograd.

The theoretical question of the regeneration of bone tissue possesses practical importance in two directions: (1) The treatment of fractures; (2) The repairing of bone defects by the transplantation of bone tissue.

It is already admitted that the best results are obtained by autoplastic grafting; but authors are not unanimous in their opinion as to the actual part played by the 'transplant.' The majority now adhere to Barth's view that the cells of the transplanted bone and periosteum perish, and are replaced by newly-formed bone tissue. According to some (Barth, Frangenheim, Grekoff), the source of newly-formed bone exists in the bone matrix of the bed into which the bone is transplanted. Others (Axhausen) believe that the periosteum and bone marrow of the 'transplant' take a prominent part in the process. A third group (Ollier, Petroff) accords an active rôle to the young connective-tissue cells surrounding the transplanted piece. A case of bone transplantation was described by me in the *Russki Wratch* of 1914, in which the transplanted portion was finally eliminated by suppuration, and nevertheless the clinical result was excellent. Such a result can hardly be explained from the point of view of the rôle of the 'transplant' alone. The eliminated bone was quite carious, just as if it had been utilized for the organizing of new tissue.

In order to throw light on this question, use was made of the method of the cultivation of tissues in vitro. I will not describe this method in detail, as it is well known from the works of Harrison, Burrows, Carrel, Pozzi, Marinesco and Nirea, Lambert and Hanes, Ingebrigtsen, Ruth, and others. Regarding the cultivation of bone, I know of only one work on the subject, that by Foot on the growth of chicken-bone marrow and its bearing on hæmatogenesis in adult life. This has, however, no special relation to bone tissue.

Briefly, the experiments were carried out in the following manner: Small pieces of bone taken from young animals (mice, kittens, rabbits) were placed on slides in homogeneous plasma, and covered with a watch-glass with a hanging drop of distilled water, which was hermetically sealed with paraffin. This preparation was placed in the incubator, and from time to time examined under the microscope. As soon as the first signs of liquefaction appeared in the medium, or sometimes even sooner, the cultures were fixed *in situ* in the usual manner. For the first experiments we used bone with its periosteum and bone marrow. The result was mostly a luxuriant growth, accompanied by intense round-cell infiltration, which partially obscured the picture of the

growth. For this reason an attempt was made to cultivate the different constituents of the bone separately. The long bones were cut longitudinally; then the periosteum was scraped off with a knife, and the bone marrow removed with a small curette; finally, the bone and periosteum were in turn subjected to experiment. It was not sufficient for our purpose to experiment with bone marrow alone, so we decided to use the spongiosa of bone instead.

The scraped bone was cut into small pieces in different directions, and placed in plasma on the slide in the usual manner. The result was a very definite and clear growth almost free from cellular infiltration, and probably arising from all living elements of compact bone (*Fig.* 209). It is true that this growth was not so luxuriant as the one produced in the experiment in which all the constituents were taken together; but on the other hand, it showed very distinctly the different forms of cells, with processes growing

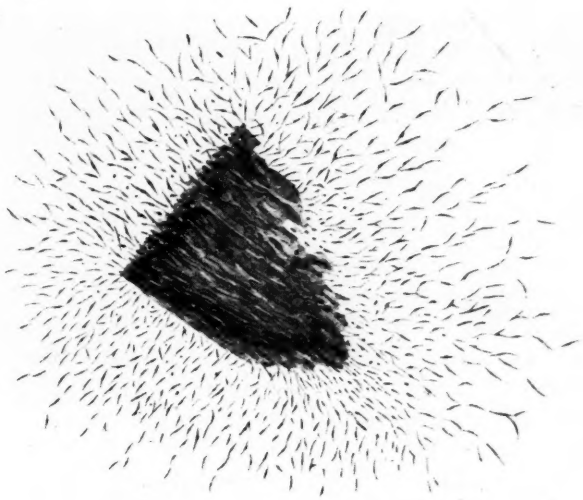


FIG. 209.—Growth from compact bone.

out of compact bone; and sometimes a connecting strand of protoplasm was noticed between the new cells and those lying in the original tissue (*Fig.* 210). Occasionally, two pieces of bone were closely adjacent to one another, and we observed that the space between them was rapidly filled by growing cells, which united the two separate parts.

The cultivation of separated periosteum gave less satisfactory results, and hardly any growth was observed. This may have been due to the fact that in young animals the periosteum is exceedingly tender, and possibly it was deprived of its vitality in consequence of the bruising it suffered in the process of being scraped off the bone.

The experiment with bone spongiosa showed an active growth, but the picture was again obscured by intense round-cell infiltration.

The result of our experiments, especially those with compact bone, seems to explain in some measure the process which takes place in the organism in

bone-grafting operations and in the healing of splintered bone, and to throw some light on its mode of action. As a matter of fact, these two processes are quite analogous, because every piece of bone which has been entirely separated off by fracture may be regarded as a free bone 'transplant.' One can hardly imagine a piece of bone within the organism in a worse condition than if it were on the slide; although it is true that the two cases are not quite parallel, inasmuch as embryonic tissues on the slide show only cell propagation without tissue formation, whereas when grafted into the organism they produce well-differentiated tissues—namely, muscle, bone, skin, lymphoid tissue, etc. (Hansemann, Askanasi, Petroff).

From the above we may conclude that a detached piece of bone must of necessity play some active part in the process of bone regeneration. We know (Bashkirtseff, Petroff) that islets of osteogenetic tissue have been noticed

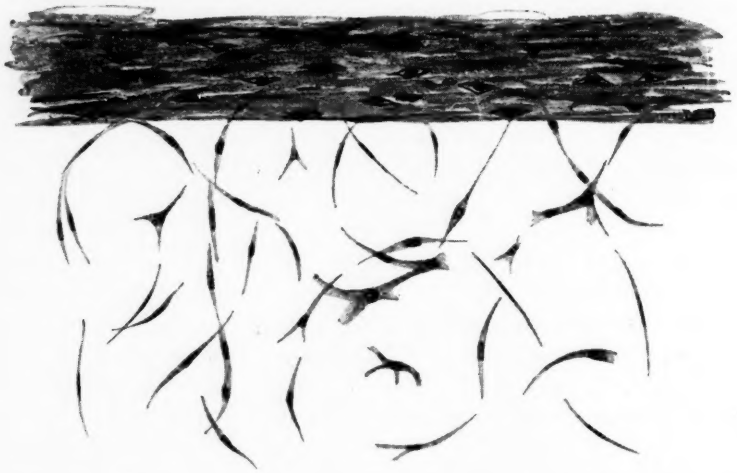


FIG. 210.—Growth from compact bone; a connecting strand of protoplasm is seen between a new cell and one lying in the original tissue.

round a piece of bone transplanted without its periosteum. Probably this osteogenetic formation arises from the growing cells of the transplanted piece; but the newly-formed bone only acquires permanent vitality when connected with the bone-matrix, by means of which it is brought into relation with the central nervous system and the other normal conditions of life. One cannot wonder that these newly-formed cells should not be permanent, as it is a general law of development that imperfect forms should gradually be replaced by more perfect ones. In addition to other things, the organism finds in the piece of transplanted bone a source of organic salts, which are necessary for bone regeneration.

Our experiments also throw some light on the rôle of blood-coagulation in the process of bone regeneration as described by Bier. By means of its fine fibrinous network, the coagulum aids the growth of the osteogenetic tissue-cells in the same manner as observed on the slide.

CONCLUSIONS.

1. Bone tissue is capable of producing a luxuriant growth in vitro.

2. The living elements of compact bone tissue are also capable of developing new cells.

3. The islets of osteogenetic tissue round a piece of bone deprived of its periosteum, and transplanted into the soft tissues, probably arise from the growing cells of the transplanted compact bone.

4. When the bone is transplanted with its periosteum, the growth is evidently more active, and this would explain the more favourable clinical results of such transplantations.

5. In order to obtain due strength, it is necessary that the bone should be connected with the matrix-bone, through which it enters into normal conditions.

6. Blood-coagulum aids the growth of osteogenetic cells by means of its fibrinous network.

7. The practical lesson gained by our experiments is as follows: splinters in non-suppurating fractures must be treated most carefully, and if possible the wound must not be interfered with. In suppurating cases, the extraction of splinters should be delayed as long as possible, in order to give the organism a chance of profiting by the regeneration of bone.

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A NOTE ON THE AFTER-TREATMENT OF SO-CALLED 'FROST-BITE.'

By FREDERICK A. JOHNS, Harrogate.

This article is intended to deal with the after-treatment in a special hospital, by methods not in common use in general hospitals, of 'frost-bite,' 'trench-bite' or 'puttee-bite,' whichever nomenclature is preferred. The class of case usually seen in hospitals in England—that is to say, the cases sent home after treatment at the front for a period of a week or so—may be roughly divided into three sections :—

1. Cases with intensely painful feet, with or without ulceration of the skin. The skin and underlying tissues are intensely hyperæsthetic, so that the slightest touch makes the patient wince.

2. Cases of painful feet, presenting in addition some loss of superficial sensation, though there is always pain on deep pressure.

3. Cases which exhibit symptoms of definite neuropathic changes, leading to paresis of the muscles and arthritic alterations.

There seems no doubt, from examination of the cases, that the condition is largely due to pressure on an anæsthetic foot or leg, as the case may be. In the case of frost-bite, the anæsthesia is due either to cold and wet, or pressure, or the two conditions combined. Pressure may result from the contraction of wet puttees and boots, and may be aggravated by the wearing of two pairs of socks in boots only made to hold one pair, a practice which may cause serious interference with the circulation. In the early stages of the war men were marched rapidly up to the trenches. With their feet and legs swollen and hot from marching, they entered the trenches and stood up to their knees in icy-cold water and mud, which caused shrinkage of the boots and puttees, and produced in the feet a localized gangrene, due largely to circulatory interference. The condition is somewhat analogous to the musculospiral paresis which may result from prolonged pressure on the musculospiral nerve in persons unconscious from anæsthesia or alcoholic excess.

Treatment.—In the first class, that is in patients with intensely painful feet, the best treatment has been found to consist in leaving the patient's feet free of bedclothes, either merely covered by a cradle left open at the end, or treated by the application of iced cloths, or such evaporating lotions as a weak solution of menthol in alcohol, painted on the feet. Care must of course be taken to avoid any ulcerated parts. If this method be adopted, in most cases the pain is quickly relieved, the patient sleeps, and morphia is seldom necessary. When the intense pain and tenderness have subsided, very gentle massage, and heat in the form of Berthollet baths or hot-air baths, have been found to be very beneficial, inasmuch as they increase the peripheral circulation, and relieve pain. The Berthollet bath is a local steam-bath. The

patient's feet are placed in a metal receptacle, to which steam is gradually admitted until the temperature is raised to about 120°, or as near that point as can be comfortably borne, the treatment lasting for about twenty minutes. The heat of the electrically produced hot-air bath, owing to its dryness, can be borne at a much higher temperature, usually about 360°.

In the second class of case, that in which the feet and legs are painful but there is a certain amount of loss of superficial sensation, I employ gentle massage, ten to twenty-five minutes daily, according to the sensibility of the patient. This is also supplemented by Berthollet baths.

The third class, in which there are definite neuropathic changes, has to be treated as a pure neuritis; for this, more or less vigorous massage is indicated if the patient can stand it. Bergonié treatment and thermo-penetration have also been found especially useful. The Bergonié treatment consists essentially of electrically-provoked muscular exercise by means of semi-cylindrical metal electrodes, suitably covered, or by electrodes of metal gauze. The current is rhythmically interrupted and reversed by means of a metronome, the main object being to obtain muscular contractions of maximum strength with a minimum of sensation. The waves induced by the make and break of the current are regular, equal, and synchronous. The great advantage of this method of treatment is that groups of muscles can be stimulated, instead of one individual muscle at one treatment.

The thermo-penetration treatment is especially useful in those cases in which joints are affected, the treatment consisting in passing through the affected limb a current of 2000 to 3000 volts and 0·5 to 3 ampères. The only immediate sensation the patient experiences is an increase in local temperature, which is greatest in the path between the electrodes. The main object of the treatment is the resultant hyperæmia. Although the results of these methods have been particularly satisfactory in most patients, there have been a certain number of cases which occurred early in the year where it has been necessary to order special boots, and supports for muscles which have lost their functions.

NOTES ON THIRTY-TWO CASES OF PENETRATING WOUNDS OF THE ABDOMEN

TREATED AT A CASUALTY CLEARING STATION IN FRANCE.

By Captain C. H. S. WEBB. R.A.M.C. (T.C.)
AND
Captain E. T. C. MILLIGAN, R.A.M.C. (T.C.)

Penetrating wounds of the abdomen form an interesting class of war surgery, and the following series of 32 cases may be of interest as a clinical record, and as exemplifying certain conclusions that can be drawn regarding the more common abdominal lesions met with at a casualty clearing station.

The notes from which the following remarks have been compiled cover a period from October 1915 to May 1916, and include all cases seen by us during that time,—a period of quiet routine not including any big rush of casualties. In all, 32 cases passed through our hands; of these, 21 were submitted to operation, while 11 were not operated upon.

Those not operated upon fall into two groups: (1) Those where there was doubt as to penetration, or where a solid viscus, such as the liver or kidney, alone had been wounded; (2) Those cases that were moribund, or too hopelessly knocked out—with perhaps multiple wounds elsewhere, or with complications, such as lung or spinal lesions—to admit of laparotomy.

Early in the series we attempted several 'forlorn hope' operations, but later, perhaps with growing caution or added experience, we have endeavoured to operate only in cases where there seemed a reasonable prospect of success.

Of the cases not operated upon, 6 recovered and 5 died, giving a mortality of 45·45 per cent, and a recovery rate of 54·54 per cent. Of the cases that were submitted to operation, 12 recovered and 9 died, giving a mortality of 42·85 per cent, and a recovery rate of 57·14 per cent.

With regard to the general condition of patients on arrival at the casualty clearing station, there are several points to be noted. A wide range of conditions may be seen. The patient may be quite cheerful, with a good colour and pulse; or may be so collapsed as to be on the point of death. The majority of cases are pale and somewhat collapsed, and usually in considerable abdominal pain. Generally speaking they react well to rest in bed, warmth, morphia, and salines. The factors entering into the causation of this difference in general condition on admission are briefly: (1) The character of the wound or wounds; (2) The length of time that has elapsed since the receipt of the wound; (3) The distance the case has been conveyed; (4) The character of the roads over which the convoy has passed. Cases suffering from commencing peritonitis stand the motor journey well, but cases of intra-abdominal hæmorrhage, or cases complicated by severe wounds of other parts of the body, stand it badly.

We have experienced difficulty in deciding when to operate; whether to operate at once, as soon as the patient is brought in, or whether to wait while shock is being combated by bed, warmth, etc. We have come to the conclusion that it is better in every case to wait from one to three or four hours before deciding to operate; and for the following reasons:—

1. Anti-shock measures will differentiate between the moribund cases and those that are capable of reaction. This may seem a truism, but it is an important truism. We have found that time spent in operating on those cases which do not respond to anti-shock measures on admission to the casualty clearing station is time wasted. We have not saved any case by rapidly opening the abdomen, expecting perhaps to find bleeding from a large vessel, and ligaturing the same. Moribund cases are very pale, have small, rapid pulses, and present a picture of severe internal bleeding; whereas in reality they are usually severe cases of shock, superimposed upon an almost negligible amount of bleeding; cases of wounds of large vessels do not reach the average casualty clearing station. Unless patients can be tided over their shock, it is useless to try any operative measures.

2. Waiting will help one to decide whether actual penetration has occurred or not. That is to say, a patient brought in by motor ambulance, suffering from a wound of the abdominal wall, will often complain of severe abdominal pain with tenderness and rigidity in and around the musculature wounded; he may even have vomited; but rest in bed will quickly clear up the diagnosis. Again, where the liver, the diaphragm, and perhaps one or other kidney, have been wounded, it is very difficult at first to be sure that there is no lesion of a hollow viscus also present. Rest in bed brings to light the progressive symptom-complex of a peritoneal infection; whereas the false impression of grave intra-abdominal injury created in the mind of the observer by many cases of simple wounds of the abdominal wall, or of the solid viscera unaccompanied by severe hæmorrhage, is dispelled, as with each hour of rest in bed the patient becomes more and more comfortable and at ease.

We should have opened several abdomens for nothing if we had operated at once and on 'principle' on every case of suspected penetrating wound of the abdomen; and the same holds good had we made our decision upon merely seeing a wound in any part of the skin over the abdominal 'danger area.' And yet this has been advocated.

Method of Examination.—*General.*—The facies—pallor, anxious expression, sinking in of the eyes—is of the utmost help in arriving at an estimation of the general condition of the patient, and in addition, working of the alæ nasi, combined with other evidences of dyspnœa, in wounds of the upper abdomen where the diaphragm is involved, is also useful.

The pulse is perhaps the most reliable guide of all. A steadily rising pulse is more to be relied upon as a determinant for operation than any other symptom or sign we know of. The general character of the pulse naturally is of great value in deciding whether or no an operation is possible.

Respirations vary mainly with the situation of the abdominal wound, and also to some extent with the damage wrought by the projectile. In an uncomplicated wound of the small intestine without much bleeding, the

respirations may not vary from the normal at all. A wound involving the diaphragm produces shallow, catchy, spasmodic breathing at a quickened rate, often 40 per minute. Where there is much bleeding, air hunger becomes noticeable. With a commencing peritonitis, again, the rate quickens, and the respirations become shallow and thoracic in type.

Temperature is no guide at all in the early stages. In a great many cases, on admission the temperature is subnormal. It is very seldom indeed that a temperature of over 99° is registered before the case has been some hours in bed. The degree to which the temperature is subnormal is a guide to the amount of shock present. A subnormal temperature and a pulse of over 140 are grave signs. If after an hour in bed such a pulse continued to rise, and remained small and unsteady, and the temperature remained subnormal or even fell further, we would not attempt any operative measures.

Vomiting as a positive sign is useful as confirmatory evidence, but its entire absence has been noted in cases where, either at operation or at an autopsy, the presence of extensive intra-abdominal injury has been ascertained. Cases of wounds of the abdominal wall not infrequently vomit, and cases of simple bullet wounds of such viscera as the liver and kidney may or may not vomit. The mental condition of these patients is very variable: one man will not remember anything since he was wounded, and another will give a detailed description of his history previous to admission. Again, we have not been able to determine in our own minds that difference in ease and comfort of transport to the casualty clearing station do not produce corresponding differences in such a symptom as vomiting. We therefore have placed little reliance on the previous history of vomiting as given us by the patient himself.

Local.—The position of the wound or wounds in the abdominal parietes may be of the greatest diagnostic importance. This is especially true where an entrance and exit wound both occur, or where the bullet is lodged under the skin on the opposite side of the abdomen, or some distance away from the point of entry. On the other hand, a single entrance wound, or multiple wounds, over the abdominal 'danger area' (which includes the back and buttocks and perineum), are simply useful as inferential evidence.

The possibility of a projectile entering through the chest wall, possibly injuring the lung, and passing on into the abdomen, must not be overlooked. The diagnosis in these cases, and in multiple scattered wounds, is often extremely difficult. We have seen a case of a bullet wound of the dorsi-lumbar cord, where there was distention, vomiting, and complaints of great pain and tenderness in the abdomen, especially over the lower half. The position and character of the wound gave us no help, and at autopsy the abdomen was uninjured.

The escape of urine, intestinal contents, or bile, or the prolapse of omentum, intestine, or (as in one case) liver, through one or other wound, is of course pathognomonic.

Abdominal pain is present in nearly every case, and varies in intensity with the severity of the wound and the temperament of the patient. Extensive destruction of the abdominal wall, or complications such as fracture of the pelvis or injury to ribs and diaphragm, increase the pain. We have not

gained from the position of the pain much help in localizing the viscus probably injured, save in the case of the liver and in some cases the kidneys; in liver wounds, pain in the right scapular region is of frequent occurrence.

Tenderness and rigidity are in nearly every case present and marked. The same remark as to localization made with regard to abdominal pain applies here also, with the reservation in both cases that muscular rigidity may be of more help than pain in localizing some cases, especially where a through-and-through wound from front to back has occurred towards the periphery of the abdomen. We think, however, that general rigidity is an important sign of some intra-abdominal lesion. Nevertheless, we have seen a patient with a simple uncomplicated bullet wound of the right kidney, who was admitted with an abdominal wall as rigid as a board all over. His face was healthy looking, his pulse quite good, and he had not vomited. We watched him for twenty-four hours, when all the rigidity disappeared save immediately over the right kidney area. We have seen wounds of the liver with a lax abdominal wall.

Briefly, we place most reliance on the facies, the pulse, and the position and character of the wound or wounds, and rely secondarily on rigidity of the abdominal wall. We deem the presence of vomiting useful confirmatory evidence, but its absence is of very little value, and even its presence may mislead, since it is a prominent factor in cases developing a 'gas gangrene' toxæmia, either in a compound tibia or femur fracture complicating a possible abdominal wound, or in the retroperitoneum or the muscular planes of the abdominal wall.

Absence of liver dullness, dullness in the flanks, and fluid thrills may occur, and are interesting to observe, though of little help in arriving at a timely diagnosis.

Hæmaturia occurs in wounds of the bladder, and sometimes in wounds of the kidney. We have had cases of wounds of the kidney which have had no hæmaturia all the time they have been under our observation, and others where hæmaturia has come on from two to three days after receipt of the wound, and yet others where it has been present from the start. We believe that in the slighter renal wounds hæmaturia if present at all is present from the first, but that in more extensive injuries the kidney function is totally inhibited for a longer or shorter period, and that possibly in some cases the ureter becomes blocked for a day or two with clot. Attacks of true renal colic occurred in one of our cases as late as the tenth day after operation on a damaged kidney which we managed to suture successfully; we believed it to be due to the passage of clot down the ureter.

Cases not Operated on.—As stated above, these fall into two main groups: (1) Those cases the seriousness of whose condition precluded the possibility of operative measures; (2) Those cases where the signs and symptoms did not warrant the assumption of commencing peritonitis or of intraperitoneal hæmorrhage, and where urgent operative measures were not required.

There were 11 cases in all not operated on: 5 died (those in the first of the above groups), and 6 recovered (those in the second group).

The treatment of the moribund cases resolved itself into the administration of morphia and the palliation of the thirst by drinks and administration of salines. The treatment in the second group consisted in dressing and temporary drainage of the wounds, short of incision in most cases, combined with rest in bed, heroin gr. $\frac{1}{8}$ as required, and limited drinks by the mouth, until the absence of injury to hollow viscera, etc., was definitely diagnosed.

The cases are recorded in the summary at the end of the paper, and the various lesions are described under the visceral headings on page 346.

Cases Operated upon.—The anæsthetic used has in nearly every case been open ether; in the last few cases it has been administered by means of a Shipway apparatus. We have given morphia gr. $\frac{1}{6}$ and atropine gr. $\frac{1}{150}$ half an hour before operation. At the operation we have lately made use of a $\frac{1}{4}$ per cent solution of novocain for infiltrating the layers of the abdominal wall at the site of incision.

We have had a shelf made to fit under the metal operating table which holds eight to ten hot-water bottles; and when necessary during the operation we have administered continuous subcutaneous saline. In one instance we believe we tided a patient over a period of very severe intra-operative shock by the addition of 1 dr. adrenalin solution plus $\frac{1}{2}$ c.c. pituitary extract—added to and given with one pint of subcutaneous saline. The addition of this adrenalin and pituitrin (for which suggestion we are indebted to Capt. R. Kennon, R.A.M.C.) to the saline given after operation to combat shock seems to us a very valuable therapeutic measure.

The Operation.

Preparation of Patient.—We have done very little save clothing the patient properly and warmly, and dealing with the skin of the abdomen. The patient is always put to bed, his tunic, trousers, boots, puttees, and underclothes are removed, and he is given pyjamas and warm bed-stockings. The abdomen is shaved and washed. On the table, when under the anæsthetic, the skin of the abdomen, etc., is washed with ether or ether soap, and then painted with tincture of iodine.

We have used in nearly every case a paramedian incision, either displacing the rectus outwards, or going through its fibres The length of the incision has depended upon what has been found inside the abdomen. The primary incision has been just large enough to allow the insertion of the hand and wrist, and has then been extended up or down, as circumstances suggested.

As soon as the wound has been enlarged to the requisite length, the cut edges of the abdominal wall are protected by means of large swabs wrung out of hot saline. The swabs also serve to cover the skin of the abdominal wall lateral to the incision, while the intestines, as they are withdrawn from the peritoneal cavity, are laid upon them.

We have found it necessary to follow a definite detailed method of examination of the abdominal viscera when the abdomen has been opened. The presence of blood, free gas, or intestinal contents is noted. The ileocæcal junction is sought for, and the ileum is traced in continuity backwards to the duodenojejunal flexure. The ileum and mesentery are examined back and front during this procedure, and each loop of intestine is drawn seriatim

out of the abdomen by the operator, and received by the assistant, who wraps the whole up in gauze tissue wrung out of hot saline. Each intestinal wound as discovered is covered in by a gauze dab wrapped round the whole circumference of the gut, and held in place by a Doyen's clamp. The whole mass of eviscerated small intestine is then temporarily covered in with hot saline packs. The cæcum, ascending, transverse, and descending colons are then examined, special care being necessary at the hepatic and splenic flexures. Also the presence of retroperitoneal hæmorrhage, and especially retroperitoneal emphysema, either of intestinal origin or due to a gas-forming organism carried in with the missile, are carefully looked for.

In the case of the more fixed viscera, such as the liver, kidneys, stomach, spleen, rectum, or bladder, it is seldom necessary to carry out a rigidly routine examination, unless the position or direction of the wound leads to the conclusion that one or more of these organs may have been wounded.

No remedial measures, with the exception of temporary hæmostasis of obvious bleeding points, are commenced until the whole number and character of the lesions present have been ascertained. We consider this an important point, especially with regard to the question of suture versus resection in the small intestine or mobile large intestine. Even as many as eleven perforations may occur within a short distance of one another in the ileum, and one resection may be made to include them all, shortening the time and immeasurably increasing the chances of success compared with simple suture.

Detailed treatment of the various lesions will be dealt with under visceral headings later.

We believe it to be very important to make a thorough attempt to find the projectile in every case in which it is retained. Infection of the track of the projectile, and more particularly the 'blind end,' where the projectile comes to rest, occurs in abdominal wounds in exactly the same way as in wounds of other parts. The clothing carried in will be found in greatest amount actually clinging to and wrapped round the ragged portions of shell causing the wound. Undeformed rifle bullets and shrapnel balls do not carry in clothing. We have seen a case (*Case* 8) die from gas gangrene toxæmia, where post morten a longish piece of high-explosive shell, with a few pieces of clothing clinging to it, had entered the abdomen; the missile was lying in the great omentum, there was no gut injury, and the case had succumbed to an infective anaerobic toxæmia admitted from without.

The mental effect of showing the patient the bullet that wounded him and telling him that it has been extracted is very considerable. We have seen a case in which a small piece of shell entered the left loin and passed through the kidney and spleen. At the operation the wounds of the kidney and spleen were dealt with successfully, and the patient was put back to bed without finding the projectile. His first question on coming round was, " Did you get it out, doctor ? " He was very depressed and made a very slow recovery up till the fourth day, when a small abscess pointed in the left axillary line over the tenth rib. This was incised and the projectile removed. The disappearance of all trace of anxiety and depression from that patient's face was well worth seeing.

The removal of the missile is also called for particularly when it has

lodged in the retroperitoneal tissues, and in such situations as the iliacus, or the loin muscles. Acute infections of retroperitoneal cellular tissues and muscular planes of the abdominal wall form one of the chief factors in the only too frequent disappointments met with in war surgery of the abdomen. Other situations that react badly to retained projectiles, are the liver, the kidneys, and the pelvic fascial structures.

Again, from the operator's point of view, to have located and perhaps extracted the missile induces a feeling that the end of the journey has been reached, and that a complete view of the damage wrought along the whole tract, from entrance wound to site of lodgement, has been obtained. If the missile is not located, then one feels that there is possibly something still left undiscovered.

The peritoneum is cleansed along the tract as far as possible by gentle dry swabbing. Eviscerated small and large intestine is washed over with normal saline before being returned to the abdomen.

Drainage tubes are inserted along the track through the parietes, a small entrance wound in the loin being enlarged sufficiently to allow a tube $\frac{5}{8}$ inch in diameter to be inserted down to, and just into, the peritoneal cavity.

Small wounds in the anterior abdominal wall are excised as far as possible and sutured round a small drain.

A drain is inserted above the pubes into the pelvis in every case, even where only blood has been found extravasated, either through a stab wound or through the lower angle of the laparotomy wound.

No time is wasted in removing every trace of blood from the peritoneal cavity; only so far as is necessary to obtain a view of the parts concerned is this carried out. We have left a good deal of blood in one or two cases, and have not had any trouble we could assign to this cause.

Suture of Abdominal Wall.—Where, as has usually been the case, we have opened the abdomen through a paramedian incision, away from the wounds of entrance or exit, we have sutured the abdominal wall in layers with continuous linen thread. In one or two instances, however, we have opened the abdomen by an incision including an entrance or exit wound; here we have used thread, but interrupted, and have excised the track of the missile, and drained its site in the incision.

Complications after Operation.

Shock.—More cases were lost from shock after operation than from any other cause. An operation involving perhaps one or more resections, with suture of other parts of intestine, or perhaps a colotomy, takes on an average from one and a half to two hours, and the handling of and pulling on intestine and mesentery inseparable from an adequate examination is productive of a good deal of shock. The patients are suffering from shock on admission, and their nervous system is to varying extents exhausted. All these factors contribute to make post-operative shock a most serious matter to face.

Persistent Vomiting.—There have been two cases of acute dilatation of the stomach, which reacted well to eserine gr. $\frac{1}{50}$, combined with gastric lavage. Lesser degrees of paralytic vomiting have been common, and have responded well to eserine gr. $\frac{1}{50}$ repeated in two hours' time, or to the administration of calomel, gr. $\frac{1}{4}$ hourly, up to 4 gr.

In cases dying of peritonitis, of course we have been unable to do much for the distressing vomiting they have exhibited.

Distention.—This has been most marked in cases of wounds of the terminal ileum and of the cæcum. Eserine, $\frac{1}{4}$-gr doses of calomel, and small injection enemata have been useful. Also, in the early stage, the adrenalin and pituitrin we have employed to combat the general shock have, we believe, helped the 'stasis distention' these cases exhibit before and after operation.

Respiratory Sequelæ.—Unfortunately these have been only too frequent, taking the form of bronchitis or a bronchopneumonia. They have seldom been severe, and have usually cleared up in from six to ten days. We hope to reduce their incidence by the use of ether vapour warmed by passing through a thermos flask containing hot water, such as is contained in the Shipway apparatus recently supplied to us.

Infections.—A spreading cellulitis of the abdominal wall, commencing in the projectile track, is not an uncommon sequela. Should the laparotomy incision pass across the track of the projectile, or include it in any way, infection of the whole incision is only too common. Such infections may be simple pus formations limited to the immediate neighbourhood of the track; or may take the form of a subacute cellulitis spreading for several inches away from the track or incision, and clearing up spontaneously in from five to seven or eight days; or an extremely acute spreading cellulitis, with or without the formation of gas, may terminate the patient's life very rapidly.

A fatal result from 'gas gangrene' toxæmia, starting round a retained missile, has been responsible for several disappointments.

The retroperitoneal tissues are easily and rapidly affected by organisms which happened to be implanted therein.

VISCERAL LESIONS.

Under this heading it is proposed to tabulate the various injuries seen as they affect the different viscera. It is not a tabulation of cases, but of wounds. That is to say, that whereas one case may demonstrate several wounds affecting different viscera, this section has been written with the idea of recording under each visceral heading the various wounds that have been observed of that viscus.

A.—CASES NOT OPERATED UPON.

Solid Viscera.

1. *The Liver.*—There have been four cases, of which three recovered and four died (*Cases* 3, 5, 10, 11).

At the autopsy on the case that died (*Case* 10), a large sloughing track ('gutter-track') had been ploughed on the surface of the right lobe of the liver by a fragment of shell that had entered through the 7th costal cartilage in the mammary line, and whose exit was through the right loin in the posterior axillary line one inch above the crest of the ilium. There were no gut lesions, yet there was an acute and rapidly fatal 'missile' peritonitis. There had been remarkably little bleeding. The liver substance was necrotic to the naked eye for a distance of half an inch from the surface of the track. The track was

about ¾ inch wide, 3 inches long, and ¼ inch deep at its deepest part. There were several other wounds of chest wall and right leg.

Of the three cases that recovered, two (*Cases* 3 and 5) discharged bile, one copiously, while the third discharged no bile (*Case* 11). In every case there was catchy, shallow, painful breathing, characteristic of a wounded diaphragm.

2. *Kidney.*—There were three cases in which the kidney was wounded: two recovered and one died. In the fatal case the colon was wounded, and also the spine, the patient having a definite concussion paraplegia.

The patients complained of intense pain in all three cases. There was hæmaturia in all three; this was copious in one case, and but slightly marked in the other two.

3. *Prostate.*—The prostate was wounded once in this series, but the bladder and a coil of ileum were coincidently wounded, and the case terminated fatally.

4. *Peritoneum and Omentum* (*Case* 8).—This was a rather remarkable case. It is recorded more fully in the summary of cases. A longish fragment of shell entered the abdomen through the left loin. It just missed the lower pole of the left kidney, passed internal to and below the splenic flexure, and came to rest in the great omentum, just below the transverse colon. It must have traversed a part of the peritoneal cavity in which coils of jejunum were lying, and yet one small scratch on a coil of jejunum, merely involving the peritoneal coat, was all the damage that was caused. The case died, very soon after being wounded, from acute 'gas gangrene' toxæmia, developing in the great omentum around the shell fragment, to which, at the autopsy, a few ragged pieces of clothing were still adherent. The liver was frothy when cut with a knife.

Hollow Viscera.

1. *Ileum.*—One case, complicated by wounds of bladder and prostate. The patient died.

2. *Colon.*—Two cases, both fatal. One was complicated by wounds of the spine with paraplegia, and of the kidney; the other by a wound of the left lung and by multiple wounds of other parts of the body.

TABLE OF VISCERAL LESIONS IN CASES NOT OPERATED ON.

VISCUS	NUMBER OBSERVED	RECOVERED	DIED	REMARKS
Liver ..	4	3	1	*Cases* 3, 5, 11, 10. All uncomplicated by other visceral injuries
Kidney ..	3	2	1	*Cases* 2, 7, 6. Fatal case complicated by wounds of spine and colon
Bladder and prostate	1	—	1	*Case* 1. Ileum also wounded
Omentum	1	—	1	*Case* 8. No gut lesion. Death from gas gangrene toxæmia
Ileum ..	1	—	1	*Case* 1. Bladder and prostate also wounded
Colon ..	2	—	2	*Case* 6. Kidney and spine also wounded *Case* 9. Multiple wounds of other parts of body.

B.—CASES SUBMITTED TO OPERATION.

Solid Viscera.

1. *Omentum* (*Case* 26).—In this case a rather large piece of shell had penetrated the abdominal wall through the right rectus. A sharp corner was sticking through the parietal peritoneum, and had bruised and slightly lacerated the great omentum. The underlying gut was uninjured. The injured omentum was excised, as also the edges of the parietal peritoneum, and the whole of the track through the other layers of the abdominal wall. The wound healed by first intention, save where loss of tissue necessitated a drain and healing by granulation. The patient had vomited before admission, and held his abdomen still and motionless.

2. *Liver* (*Cases* 19, 14, 16, 23, 24, 27).—Six cases in all, five fatal. The high mortality of this series is accounted for by the fact that in all but one case (of recovery) there were wounds of other viscera more directly responsible for the fatal result.

In the case that recovered, we opened the abdomen expecting from the signs and symptoms to find possibly other viscera injured, but the shell fragment was imbedded in the right lobe of the liver, from which we were able to extract it. We have been a little surprised and encouraged by the ease with which liver bleeding can be controlled in all but the severest lacerations, which naturally do not reach the casualty clearing station.

3. *Kidney* (*Cases* 21, 22, 30, 14, 27).—In the three cases that recovered, we were able in two instances to control the bleeding by means of mattress sutures. In the third we had to perform nephrectomy, since the above method was not sufficient to produce hæmostasis in the ragged and rapidly bleeding tear in the kidney (*Case* 30) The first case (*Case* 21) was complicated by a wound of the transverse colon, and the second (*Case* 22) by a wound of the spleen, also dealt with by suture.

Of the fatal cases, *Case* 14 was a simple graze, and in *Case* 27 the kidney was torn in half, the patient dying on the table from bleeding from the kidney as well as from an extensively lacerated liver.

4. *Pancreas* (*Cases* 14, 16).—Two cases, both fatal, and both complicated by other severe intra-abdominal injuries. In *Case* 14 a co-existing wound of the second part of the duodenum was overlooked at the operation, and in *Case* 16 there were wounds of the stomach, liver, and fourth part of the duodenum as well. The latter case lived four days, developing a pancreatic fistula, but ultimately succumbed on the fourth day from a toxæmia due to a gas-forming organism apparently carried in on the fragment of shell. The heart blood was frothy, and there was extensive retroperitoneal hæmorrhage, in which were commencing gas formations. Two holes in the stomach and the hole in the fourth part of the duodenum were sutured, and a gastro-jejunostomy also performed. The stomach wounds and gastrojejunostomy were healing well, but there was some doubt as to the wound in the duodenum.

5. *Spleen* (*Case* 22).—One case. There was a star-shaped wound of the lower part of the postero-external border of the spleen, about ¾ inch in diameter

and just involving the actual border. There had been a good deal of hæmorrhage both from the spleen and from a coincident wound of the left kidney. The bleeding was stopped by mattress sutures, after trimming the edges of the wound a little. Recovery.

6. *Prostate* (*Case* 31).—One case. The rectum and bladder were also wounded. Recovery. (See under *Rectum*.)

Hollow Viscera.

1. *Stomach* (*Case* 16).—One case. The liver, pancreas, and duodenum were also wounded. There were two wounds in the stomach, one on the anterior and the other on the posterior surface. Each was about $\frac{1}{8}$ inch in diameter, in neither was there any pouting of mucous membrane, and they were easily closed by purse-string sutures. The patient had vomited six or seven times since he was hit. No hæmatemesis. He lived four days, and then died from ' gas gangrene ' toxæmia. (See under *Pancreas*.)

2. *Duodenum* (*Cases* 14, 16).—Two cases. Both patients died. In *Case* 14 the liver, pancreas, and kidney were also wounded. In this case the bullet had entered the right hypochondrium in the mid-axillary line, and had its exit through the left lumbar region in the posterior axillary line. It had passed through the right lobe of the liver, thence behind the gall-bladder and above the hepatic flexure, and, travelling retroperitoneally, had made an entrance and an exit wound (small punctures) in the second part of the duodenum, just above the ampulla of Vater, had ploughed along the posterior part of the head and body of the pancreas, and ended by grazing the anterior surface of the lower pole of the left kidney. The superior mesenteric vessels, and the vena cava and aorta, had all escaped injury. The retroperitoneal course was not ascertained until the autopsy. The patient died seven hours after a simple exploratory laparotomy with pelvic drainage.

In *Case* 16, the liver, stomach, and pancreas were wounded. (See under *Pancreas* and *Stomach*.)

3. *Jejunum and Ileum* (*Cases* 12, 15, 20, 28, 29, 13, 25.)—There were seven cases in all, of which five recovered and two died.

Of the two that died, in *Case* 13 the jejunal wound was large and ragged, involving the whole circumference of the gut, and situated about 8 inches from the duodenojejunal flexure. Also the jejunal mesentery there was split for about $1\frac{1}{2}$ inches towards the spine, and in the tear a large vessel was bleeding. In addition, the transverse colon was completely divided, with a V-shaped tear in the transverse mesocolon, the great omentum distal to the colon also being badly lacerated. These injuries were caused by an undeformed rifle bullet. The jejunum was resected and lateral anastomosis done. After dealing with the mesentery, the mesocolon, the colon, and the omentum, the operation had taken one and a half hours, and the patient died of shock fourteen hours later. At the autopsy, the appendix vermiformis was found to have been cleanly divided by the bullet. This was overlooked at the operation, but there was remarkably little peritonitis, even round this open appendix.

The other fatal case (*Case* 25) seems to us to be an example of a resection practised too near the wounded area, or, in other words, in a devitalized portion

of gut. There were four small punctures in the ileum close together. Three of these were included in a resection of bowel 6 inches long, and an end-to-end anastomosis was done. The fourth hole was sutured. The wounds were from 1 to 2 feet away from the ileocæcal junction. Operation was done twenty-five hours after the patient was wounded, and death took place twelve and a half hours afterwards. At the operation, there was well-marked plastic peritonitis round the terminal ileum and cæcum, and post mortem there was an acute generalized peritonitis, the junction having given way. In addition, there was commencing gas formation in wounds of the right buttock, through one of which the shell fragment had entered the abdomen.

Of the cases that recovered, two (*Cases* 12, 29) were simple multiple wounds of the small intestine, no other viscera being wounded. *Case* 12 was twenty-nine and a half hours wounded when operated upon, yet he was very fit. There were six holes made by the bullet in the ileum, two holes close together about 10 feet, and four close together about 4 feet, from the ileocæcal junction. The first two were resected with about 9 inches of gut in lateral anastomosis, the other four required about $2\frac{1}{2}$ feet of ileum to be resected. The patient recovered. Five of the wounds were punctures, with little pouting of mucous membrane and remarkably little extravasation of intestinal contents. The other one being a very considerable tear, involving nearly the whole circumference of the gut, there was considerable leakage of intestinal contents, which occupied the pelvis and right iliac fossa, but the upper abdomen was uninfected. This patient had a pulse of 88 on leaving the field ambulance, which had risen to 108 on admission; he had only vomited twice between the wound and the operation. *Case* 29 was a shell wound of the jejunum. There were four small holes close together, in the last of which the small fragment was found imbedded. Including all these lesions, about 6 inches of gut were resected, with end-to-end anastomosis.

In the other three cases (*Cases* 15, 20, 28) there were other viscera wounded at the same time; in *Cases* 15 and 20 the sigmoid was wounded; in *Case* 28 there were four holes in the transverse colon. For *Cases* 15 and 28 resection alone of the ileum or jejunum was performed. In *Case* 20 there were eleven holes in the ileum and jejunum, and another in the sigmoid colon; six of the holes in the ileum were included in one resection of $2\frac{1}{2}$ feet of gut, while the five in the jejunum were closed with sutures; the colon wound was also sutured. The patient made an uneventful recovery.

Where the length of bowel injured is small (under 1 foot), the part above seems as a rule to be distended, while that below is collapsed; but where there are multiple injuries, with at times healthy portions of gut in between the groups of lesions, there would seem to be little differentiation between a distended portion above and a collapsed portion below. Especially is this so where the terminal ileum is affected. Here there is practically no collapsed part below, while above there may be an area of distended bowel just above the wounded loop or loops; above that again the bowel may be quite pale and collapsed. The longer the interval between wound and operation, the more distention there is above the wounded segment. Again, with the onset of peritonitis, the distention, as is to be expected, becomes more acute.

There is, as it were, a 'block' in the intestinal canal at the wounded portion, and above this the bowel becomes progressively 'filled up' with intestinal secretions. In doing a resection it is important to take more bowel away above than below the actual lesions.

Again, it is much better to sacrifice a piece of comparatively healthy bowel in between two wounded areas, including both wounded portions and the connecting healthy part in between, in one resection, than to perform two resections. Time is saved, and also there is less risk of subsequent stasis with distention and vomiting. Should there be over two feet in between the resections, then it would be better to perform the two; under two feet we think it better to remove the intervening foot or foot and a half of healthy bowel. The local 'intestine shock' inseparable from any traumatic lesion of the bowel is probably present several inches above and below the actual site of the lesion.

All cases of wounds of the small intestine that recovered exhibited some degree of distention after operation; others have vomited for some considerable while, necessitating in one case gastric lavage; but in all except this one the vomiting and distention have been overcome by the administration of eserine or $\frac{1}{4}$-gr. doses of calomel, commencing the day after operation. We also have some reason to think that the administration of pituitrin and adrenalin in subcutaneous saline, immediately the patient gets back to bed after operation, is of some use not only in combating general post-operative shock, but also in combating the local temporary paresis to which we believe this post-operative distention and vomiting to be due.

The amount of intestinal contents that escapes from the gut into the peritoneum depends on two factors—the size of the wound, and the time. We have only noted once any considerable quantity of ileal contents extravasated. In this case (*Case* 12) operation was performed twenty-nine and a half hours after wounding, and there were six holes in the small intestine, one of them being large and ragged. In another case (*Case* 25), with an interval of twenty-five hours between wound and operation, we noted a 'curiously active plastic peritonitis' of the lower ileum and cæcum. There were four minute holes in the small intestine only. In the other five, one case (*Case* 13) had $2\frac{1}{2}$ pints of blood in the abdominal cavity, so that an accurate estimation of the amount of intestinal extravasation was impossible; while the other four showed hardly any extravasation whatever. Their histories varied from seven and a half to twenty-two hours.

4. *Cæcum* (*Cases* 18, 32).—Two cases; one recovered and the other died. In the fatal case the transverse colon was also wounded, while there were no less than six other shell wounds on parts of the body other than the abdominal cavity.

The case that recovered exhibited very considerable distention for some days after operation. It was a simple shell wound from before backwards immediately over the cæcum. There were two ragged wounds in the cæcum which were sutured.

5. *Appendix* (*Case* 13).—One case. The jejunum and transverse colon were also wounded, and the wounded appendix, although cut clean across by the bullet, was not discovered at the operation.

6. *Colon* (*Cases* 15, 20, 21, 28, 13, 17, 18).—Seven cases, all complicated by wounds of other viscera. Four recovered and three died.

Of the four cases that recovered, the ileum was wounded in two cases, the jejunum in one, and the kidney in the other. In two cases the transverse colon was wounded, and the iliac colon in the other two. In *Case* 15, where the ileum was wounded at the same time, an inguinal colotomy was performed for a rather large laceration of the iliac colon. A Paul's tube was tied into the laceration. The mesosigmoid was used to shut off the general peritoneum from an iliacus muscle badly infected by extravasated colon contents. The muscle was drained successfully on the outer side of the colostomy. The other three cases presented in each instance from two to four small holes either in the sigmoid or transverse colon, wounds which were easily sutured and did not necessitate either temporary colostomy or resection.

Of the three cases that died, in one (*Case* 13, transverse colon) the jejunum and appendix were also wounded. In *Case* 17 the descending colon was completely severed by a bullet entering the left buttock, the missile dividing in its course the left gluteal artery, the spermatic vessels, and a big branch of the inferior mesenteric artery. *Case* 18 had two large perforations of the transverse colon, for which about 3 inches were resected, with end-to-end anastomosis. In addition, there were a wound of the cæcum and seven other wounds in other parts of the body, including a compound fracture of the fibula which was very foul and lacerated. This patient died of shock, largely due, we believe, to the time occupied after the laparotomy in dealing with the other wounds. We intend trying, as far as possible, in the case of multiple wounds, one of which penetrates the abdomen, to deal with the abdominal wound first, and leave the others till the patient is over the shock of the laparotomy before undertaking any extensive operative measures for their treatment.

7. *Rectum* (*Case* 31).—One case. This was of an interesting nature. The missile, a small fragment of shell, entered the right ischiorectal fossa in its posterior part. The missile had entered the rectum posteriorly and a little to the right, at the upper end of the anal canal, had traversed the lumen of the gut, and had passed out through that portion of the rectum in contact with the prostate. It had traversed the upper portion of the prostate, emerging into the bladder behind the internal urinary meatus, and then passed through the fundus of the bladder, below the peritoneal reflection, and out through the left rectus. The man was hit three hours after last passing urine, so presumably there was sufficient urine in the bladder to raise the peritoneum out of harm's way. The apertures of entrance and exit in the rectum were easily felt, and just admitted the very tip of the index finger. The exit wound through the left rectus was about the size of a shilling. There was a little blood in the rectum, but only a very little urine. Urine was escaping freely by the hypogastric wound through the left rectus. A suprapubic cystotomy, combined with forcible dilatation of the anal sphincters, was done, and the patient recovered.

8. *Bladder* (*Case* 31).—One case. (See under *Rectum*.)

TABLE OF VISCERAL LESIONS IN CASES OPERATED ON.

VISCUS	NUMBER OBSERVED	RECOVERED	DIED	REMARKS
Omentum	1	1	—	*Case* 26
Liver ..	6	1	5	*Cases* 19, 14, 16, 23, 24, 27. All the fatal cases were complicated by wounds of other viscera
Kidney ..	5	3	2	*Cases* 21, 22, 30, 14, 27.
Pancreas ..	2	—	2	*Cases* 14, 16. Both were complicated by wounds of other viscera
Spleen ..	1	1	—	*Case* 22. Kidney also wounded
Prostate ..	1	1	—	*Case* 31. Rectum and bladder also wounded.
Stomach ..	1	—	1	*Case* 16. Liver, pancreas, and duodenum also wounded
Duodenum	2	—	2	*Case* 14. Liver, pancreas, and kidney also wounded *Case* 16. Liver, pancreas, and stomach also wounded
Jejunum and ileum ..	7	5	2	*Cases* 12, 15, 20, 28, 29, 13, 25. All complicated by other wounds, save three
Cæcum ..	2	1	1	*Cases* 18, 32.
Appendix	1	—	1	*Case* 13. Jejunum and transverse colon also wounded
Colon ..	7	4	3	*Cases* 15, 20, 21, 28, 13, 17, 18. All complicated by wounds of other viscera
Rectum ..	1	1	—	*Case* 31. Bladder and prostate also wounded
Bladder ..	1	1	—	*Case* 31. Rectum and prostate also wounded

SUMMARY.

1. We believe it advisable not to operate at sight and on principle on every case of suspected penetrating wound of the abdomen, but to make as definite a diagnosis as is possible before deciding whether to operate or not.

2. We think it advisable to wait a certain time after the case has been admitted, for the following reasons :—

a. To combat shock.

b. To distinguish between moribund cases and those that rally with 'anti-shock' measures.

c. To endeavour to distinguish cases requiring operation from those likely to recover without operation—i.e., that group of cases which rally with anti-shock measures.

3. It is essential to operate in every case that rallies well, where after due consideration we believe a hollow viscus to have been wounded, or where we have reason to suppose that progressive hæmorrhage is taking place.*

4. It is useless to operate in bad cases that do not respond to pre-operative shock therapeusis.

5. We do not think it advisable at present to operate in a casualty clearing station on cases in which we have reason to believe solid organs alone are injured and in which there are no signs of continued hæmorrhage.

* It is often very difficult to distinguish 'gas gangrene toxæmia' and 'progressing shock' from hæmorrhage.

6. During operation, it is of the utmost importance to follow a rigid routine method of examination of the abdominal contents, keeping in one's mind as far as possible the track of the wound.

Minor points are :—

a. To make a complete and detailed estimate of the number and character of all the lesions wrought by the projectile, before attempting any remedial measures.

b. The performance of one resection of gut, where possible, rather than multiple sutures.

c. Not to place sutures in devitalized tissues.

d. A careful search for the missile.

e. Completeness of operation especially thorough closure of the inevitably large laparotomy wound. We suture the abdominal wall in layers.

7. Post-operative shock is never negligible, and in most cases is almost certain to be the most dangerous complication to be feared after the case has left the table.

Our best thanks are due to the Officer Commanding, Lieut.-Col. D. L. Harding, D.S.O., for his kind and ready help, and to Col. H. A. Thompson, C.M.G., and Col. T. Sinclair, for valuable advice and assistance.

A.—LIST OF CASES NOT SUBMITTED TO OPERATION.

Case 1.—*October* 26, 1915.

VISCERA WOUNDED.—Prostate ; bladder ; ileum.

MISSILE.—Shell fragments (multiple).

WOUNDS OVER ABDOMEN.—*Entrance* : Right ischio-rectal fossa. *Exit* : Nearly through skin over left rectus, midway between pubes and umbilicus.

OTHER WOUNDS.—(*a*) Wound of right thorax, fracturing a rib. (*b*) Multiple wounds right and left thighs, right knee, left elbow, and wound in mastoid region.

SIGNS AND SYMPTOMS.—Admitted very collapsed, bleeding from wound in right buttock ; abdominal pain over lower half. Upper abdomen moved well ; lower abdomen tender and rigid. Gas escaping from exit wound. No vomiting.

TIME BETWEEN WOUND AND ADMISSION.—16 hours.

TREATMENT.—No operation was done, as patient was much too ill. Multiplicity of wounds made it difficult to obtain a clear picture of abdominal condition.

RESULT.—Died 3½ hours after admission.

REMARKS.—*Post mortem*. The thoracic wound had not injured lung. Abdominal wound : The missile had entered right ischiorectal fossa, passed upwards beside the rectum, through the right half of prostate and base of bladder, and out through peritoneal surface of bladder ; it lacerated a coil of small intestine lying in the pouch of Douglas. Other wounds in no way remarkable.

Case 2.—*November* 30, 1915.

VISCERA WOUNDED.—Kidney (left).

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance :* Left loin, outer border erector spinæ, between 11th and 12th ribs (small). *Exit :* Anterior axillary line, 2 inches down and out from nipple, a tiny puncture smaller than entrance.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient in great pain. No vomiting. Abdomen rigid and tender, especially over left loin muscles. Hæmaturia well marked.

TIME BETWEEN WOUND AND ADMISSION.—8 hours.

TREATMENT.—Expectant. Rest in bed, morphia, and urotropine.

RESULT.—Recovery.

REMARKS.—After a few hours the abdomen became softer. No signs of peritonitis developed. Profuse hæmaturia for three days. Urine porter coloured. Discharged to base Dec. 3, 1915.

Case 3.—*December* 16, 1915.

VISCERA WOUNDED.—Liver.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Right hypochondrium, just outside the nipple line, through 6th rib. *Exit:* Right lumbar region, 2 inches from outer border of erector spinæ, 3 inches above crest of ilium.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—On admission, fairly free oozing of dark blood from posterior wound. General condition good. Not much pain. No vomiting. Tenderness and rigidity in right lumbar region. None on left side. No hæmaturia. No jaundice. No signs of peritonitis or continued bleeding.

TIME BETWEEN WOUND AND ADMISSION.—10½ hours.

TREATMENT.—Expectant. Rest in bed, morphia and ¼-grain dose of calomel, repeated hourly to 2 grains.

RESULT.—Recovery.

REMARKS.—In all probability the kidney was also wounded, but in absence of hæmaturia a definite diagnosis cannot be made. Discharged to base Dec. 20, 1915. All pain and tenderness had disappeared.

Case 4.—*December* 16, 1915.

VISCERA WOUNDED.—None.

MISSILE.—Bullet.

WOUND OVER ABDOMEN.—*Entrance:* Anterior abdominal wall, 1½ inches inwards and upwards from anterior superior iliac spine on right side. *Exit:* In back, through *left* erector spinæ at level of 4th lumbar vertebra.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Abdominal pain, rigidity and tenderness confined to right lumbar iliac regions of abdomen. No vomiting. No signs of peritonitis, or peritoneal hæmorrhage. No hæmaturia. Patient complained of feeling of numbness in right foot.

TIME BETWEEN WOUND AND ADMISSION.—5 hours.

TREATMENT.—Expectant.

RESULT.—Recovery.

REMARKS.—From the positions of the wounds it may be assumed that the bullet traversed the peritoneal cavity in the vicinity of the cæcum. An area of anæsthesia was found over the whole of the foot, and over one-third of outer surface of leg on the right side. Patient improved rapidly. Discharged to base Dec. 20, 1915.

Case 5.—*December* 18, 1915.

VISCERA WOUNDED.—Liver.

MISSILE.—Bullet.

WOUND OVER ABDOMEN.—*Entrance:* A tiny puncture in 6th space, right mammary line. *Exit:* The size of a florin. Through 9th rib in a line with angle of scapular.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Abdomen rigid and tender in upper half. Patient had vomited once or twice before admission.

TIME BETWEEN WOUND AND ADMISSION.—38 hours.

TREATMENT.—Expectant. As there were no signs of a spreading peritonitis, and the patient's general condition improved rapidly, no operation was done.

RESULT.—Recovery.

REMARKS.—On the day after admission a copious discharge of golden bile escaped from the posterior wound. This continued till his discharge to the base on Dec. 24, 1915. On the two days previous to his transfer the bile became dark green in colour, but was never offensive. There was apparently no lack of bile in the fæces, which were well formed and of normal colour. No jaundice.

Case 6.—*January* 1, 1916.

VISCERA WOUNDED.—Colon, ascending retroperitoneal aspect. Right kidney, lower pole grazed by bullet. Spine, bullet perforated body of 4th lumbar vertebra cleanly, very little comminution. Blood-clot in spinal canal. No gross injury to cauda equina.

MISSILE.—Bullet.

WOUND OVER ABDOMEN.—*Entrance :* Right loin, mid-axillary line through 11th rib, small puncture. *Exit :* Left loin, outer edge of erector spinæ, just above crest of ilium. Size of sixpence. Track on right side in retroperitoneal tissue, on left deeper, and through muscles of loin.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Smart hæmorrhage from exit wound on admission. Patient collapsed and cold. Abdomen rigid and tender all over, most marked in right lumbar region. Patient had vomited twice. Weakness in both legs. No absolute paralysis. Retention overflow of urine.

TIME BETWEEN WOUND AND ADMISSION.—29 hours.

TREATMENT.—Patient improved somewhat with salines, warmth, and morphine. A wound of the ascending colon was diagnosed and it was decided to open the abdomen. This, however, the patient refused.

RESULT.—Died.

REMARKS.—On the third day after admission a gas infection developed in exit wound, and a spreading cellulitis for a wide area round entrance wound. The tissues over cæcum and buttock became swollen and brawny. Hiccough was troublesome, but there was no vomiting. Patient lived nine days after admission, and then died.

Post mortem, there was extensive retrocolic and retroperitoneal suppurative cellulitis from the wound in the colon.

Case 7.—*January* 29, 1916.

VISCERA WOUNDED.—Kidney.

MISSILE.—Shell fragment.

WOUND OVER ABDOMEN.—*Entrance :* Through lower costal margin, just external to mammary line and just in front of anterior axillary line on right side. *Exit :* Through erector spinæ of same side, 1 inch from middle line, level with 2nd lumbar spine. Size of a shilling.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—On admission patient was in great pain, very anxious and distressed, but general condition good. The abdomen was tender and board like, most marked over upper half of right rectus. No vomiting. Copious hæmaturia. Hiccough and diaphragmatic spasm were marked at first.

TIME BETWEEN WOUND AND ADMISSION.—36 hours.

TREATMENT.—Expectant. With warmth, and the exhibition of morphine, he quieted down and rapidly improved.

RESULT.—Recovery.

REMARKS.—From the positions of the external wounds it may be assumed that the missile traversed the liver as well as the kidney. The pain and tenderness over the liver disappeared at the end of four days. Microscopic hæmaturia also ceased on the fourth day. Discharged to base on Feb. 1, 1916.

Case 8.—*April* 16, 1916.

VISCERA WOUNDED.—Peritoneum; omentum.

MISSILE.—Shell fragment.

WOUND OVER ABDOMEN.—*Entrance:* Left loin, outer edge of erector spinæ, 2 inches above crest of ilium, large and bleeding freely. *Exit:* None. The missile, large and ragged, was lying in great omentum in the angle of the splenic flexure.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient admitted apparently moribund, extremely pale and cold, with a pulse hardly perceptible. The abdomen was lax and not painful or tender anywhere. He seemed dazed. A diagnosis of severe intra-abdominal hæmorrhage was made.

TIME BETWEEN WOUND AND ADMISSION.—5¼ hours.

TREATMENT.—Patient had been brought from an advanced dressing station, but he did not respond to various restorative measures, and died without any operative measures being considered possible.

RESULT.—Died 19 hours after being hit.

REMARKS.—*Post mortem.* No blood in peritoneal cavity. The great omentum wherein the shell fragment was imbedded was green and gangrenous for about half an inch all round. Neither transverse nor descending colon had been wounded, nor any coil of intestine. There was one small scratch just involving peritoneal coat on one coil of jejunum. There were signs of gas infection of the retro-peritoneal tissues along the track of the projectile. Kidney was untouched. Liver was 'frothy' to a remarkable extent on section. Death due to acute gas gangrene toxæmia absorbed from peritoneum only 19 hours after infliction of wound.

Case 9.—*April* 30, 1916.

VISCERA WOUNDED.—Colon: a long longitudinal tear in descending colon (externally); another, half an inch in diameter, in internal aspect of bowel. (A small fragment had entered left lung.)

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—*Entrance:* Multiple wounds scattered over back and left side of chest and loin. No exits.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient cold and pulseless, with considerable dyspnœa. Abdomen rigid and tender on left side. Vomiting frequently.

TIME BETWEEN WOUND AND ADMISSION.—13 hours.

TREATMENT.—Patient too bad to attempt operative measures.

RESULT.—Died 34 hours after wound.

REMARKS.—*Post mortem.* One fragment only had entered abdomen and produced the tear described above. Another had wounded left lung.

Case 10.—*April* 30, 1916.

VISCERA WOUNDED.—Liver.

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—*Entrance:* Through 7th costal cartilage in mammary line. *Exit:* Right loin, 1 inch above iliac crest in posterior axillary line.

OTHER WOUNDS.—Multiple wounds of chest wall and right leg.

SIGNS AND SYMPTOMS.—Patient very ill and in great pain. Abdomen tender and rigid. Vomiting.

TIME BETWEEN WOUND AND ADMISSION.—13 hours.

TREATMENT.—Expectant.

RESULT.—Died 46 hours after wound.

REMARKS.—*Post mortem.*—A large lacerated and extremely foul wound of right lobe of liver found—'gutter type.' Along the track were scattered innumerable fragments of clothing. No gut lesions, but a widespread general peritonitis from 'missile' infection.

Case 11.—*May* 22, 1916.

VISCERA WOUNDED.—Liver.

MISSILE.—Bomb fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Right hypochondrium, 6th rib, just outside nipple line. *Exit:* None.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient's general condition good. He had the spasmodic, painful, shallow, 'catchy' breathing characteristic of a wounded diaphragm; also there was pain over the right hypochondrium, in the upper part of right flank, and over right scapular region. The right rectus and oblique muscles were rigid, and there was tenderness to deep pressure up under the right costal margin.

TIME BETWEEN WOUND AND ADMISSION.—10 hours.

TREATMENT.—Expectant. With rest in bed and heroin, pain disappeared in 14 hours.

RESULT.—Recovery.

REMARKS.—Discharged to the base on May 28, 1916.

B.—LIST OF CASES SUBMITTED TO OPERATION.

Case 12.—*November* 16, 1915.

VISCERA WOUNDED.—Ileum: six holes in ileum, namely, two close together 10 feet from cæcum, and four (one a bad laceration), 4 feet from cæcum.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Just above and behind great trochanter right side, going through ileum. *Exit:* Bullet found under skin over right rectus, half-way between pubis and umbilicus.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient had vomited twice before admission. Lower half of abdomen board-like and tender. General condition good. Pulse 108, and apparently rising (88 at field ambulance).

TIME BETWEEN WOUND AND ADMISSION.—29½ hours.

TREATMENT.—Laparotomy through right rectus muscle under open ether. Gas and contents of small gut escaped on opening abdomen. Bullet had perforated ileum, missed lower edge of cæcum and wounded the small intestine in six places (*vide* under *Viscera Wounded*). For first group of two holes, 9 inches resected, with lateral anastomosis; for second group of four holes, 2½ feet resected, with lateral anastomosis. Drain-tube into pelvis through suprapubic 'stab.' Drain into right flank through lower angle of incision. Incision closed in layers.

RESULT.—Recovery.

REMARKS.—The holes in the gut, with the exception of one bad laceration near the cæcum, were small and could easily have been sutured, but the bowel in their immediate proximity was œdematous and injected, and appeared much bruised; therefore resections were done. There was a considerable quantity of ileal contents in the pelvis and right iliac fossa, but the extravasation was limited to these regions by recent adhesions. The patient made an uninterrupted recovery, save that the operation wound suppurated and some stitches had to be removed. Discharged to base Dec. 3, 1915. Heard from Dec. 19. Wounds healing well, tubes out; and Jan. 16, 1916, had abscess in buttock due to a bedsore opened. Abdominal wounds healing well.

Case 13.—*November* 20, 1916.

VISCERA WOUNDED.—Jejunum: large ragged wound 8 inches from duodenojejunal flexure, including a V-shaped tear in mesentery. Transverse colon: cut clean across, with large V-shaped tear in transverse mesocolon. Appendix vermiformis: cut in two. Not found at operation. Omentum: prolapsed, through exit wound.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Just above right great trochanter. *Exit:* Through left rectus to left of umbilicus. Great omentum prolapsed through exit wound, which was large and ragged.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient apparently very well when he left field ambulance, but on admission was collapsed and seemed on the point of death. Face pale, extremities cold, pulse hardly perceptible. Respiration, sighing and deep. Abdomen rigid and tender all over. Prolapsed omentum in exit wound. Good deal of dark blood oozing from exit wound.

TIME BETWEEN WOUND AND ADMISSION.—12 hours.

TREATMENT.—With 'salines,' hot-water bottles, and pituitrin, patient rallied sufficiently to allow laparotomy to be performed five hours after admission. Median laparotomy. About 2½ pints dark blood escaped. Bleeding vessel seen in tear in mesentery. (1) Resection 2 feet jejunum, including tear in mesentery, lateral anastomosis; (2) Hæmostasis transverse colon; (3) Both ends divided, transverse colon brought out of upper end of incision, proximal opening tied round a Paul's tube, distal opening closed with sutures; (4) Greater part of great omentum excised. Drain tubes into pelvis and into exit wound. Wound closed elsewhere.

RESULT.—Died.

REMARKS.—The patient lived for fifteen hours, and then succumbed to shock. A divided appendix was found. No more bleeding had occurred, and there were no signs of peritonitis, save round the appendix. The bullet had perforated the ileum, making a small hole, and had entered the peritoneum through the right psoas, just missing the iliac vessels. It then cut the appendix, missed the cæcum, and passed over the lower end of the ileum. It there apparently turned on its axis, as the wounds of jejunum, mesentery, and colon were very ragged and extensive. The exit wound in left rectus was badly lacerated.

Case 14.—*December* 7, 1915.

VISCERA WOUNDED.—Liver: extreme lower and posterior part right lobe. Missed gall-bladder. Duodenum, second part: two holes right and left borders. Pancreas: bullet traversed head and body of pancreas, and then just grazed the left kidney on the anterior surface, lower pole.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Right hypochondrium on mid-axillary line. *Exit:* Left lumbar region, posterior axillary line; larger and more ragged than entrance. Size of florin.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Abdomen distended, rigid and tender. Rigidity and tenderness most marked above umbilicus. No dullness in flanks. No hæmaturia. Patient collapsed and in great pain.

TIME BETWEEN WOUND AND ADMISSION.—24 hours.

TREATMENT.—Laparotomy through median incision. Liver perforation discovered and found to have ceased bleeding. Retroperitoneal emphysema noted, but significance not realized. Further course of bullet not determined at operation. Colon, stomach, spleen, and jejunum all carefully examined, but no lesions found in any. Much retroperitoneal hæmorrhage round hepatic flexure of colon and second part of duodenum. Incision closed save for drain into pelvis.

RESULT.—Died.

REMARKS.—Patient died seven hours later from shock. The two wounds of the duodenum, and the pancreatic and kidney lesions were found.

Post mortem. The retroperitoneal tissues necrotic and blood-stained. Holes in duodenum were (1) anterior and to the right, second part duodenum; and (2) exit 1 inch above bile papilla, apparently behind bile-duct. The superior mesenteric vessels escaped injury, as also vena cava and aorta, bullet traversing the pancreas towards its exit through left loin. There was not enough blood extravasation to have caused death.

Case 15.—*December* 23, 1915.

VISCERA WOUNDED.—Ileum: two holes close together. Small, with pouting of mucous membrane. Colon, iliac portion: two holes: (1) intraperitoneal; (2) retroperitoneal. Bullet lodged in iliacus muscle.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* 1 inch below and to left of umbilicus. *Exit:* Bullet lodged in left iliacus muscle. No other wounds.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Had vomited once before and once after admission. Complained of pain over lower half of abdomen, radiating down inguinal and adductor regions. Tenderness and rigidity not marked, but most evident over left iliac region. General condition good.

TIME BETWEEN WOUND AND ADMISSION.—7½ hours.

TREATMENT.—Under ether, incision through left rectus, evacuating a fair amount of blood. No obvious soiling of peritoneum, which however was becoming red and rough. (1) For two holes in ileum resection and lateral anastomosis performed; (2) Iliac colon mobilized by incision through peritoneum on outer aspect, bullet extracted from iliacus muscle. Iliac colon brought out of separate 'gridiron' incision, as for colostomy. Wound on peritoneal surface sutured, retroperitoneal wound enlarged and Paul's tube tied in. Abdomen closed, save for (1) tube into pelvis, and (2) tube on outer side of colostomy to drain the iliacus muscle.

RESULT.—Recovery.

REMARKS.—Patient made an uninterrupted recovery, save for an attack of acute dilatation of the stomach on the night after operation, which was treated by gastric lavage and eserine gr. $\frac{1}{50}$. Discharged to base Jan. 3, 1916. Heard from Jan. 10. Doing well in England.

Case 16.—*January* 8, 1916.

VISCERA WOUNDED.—Liver: left lobe near margin. Stomach: both anterior and posterior surfaces, mid-way between curvatures, small holes. Duodenum: fourth part. Pancreas: lower border of body.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Left hypochondrium just inside nipple line, through about 8th cartilage. Size of threepenny piece. *Exit:* None.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Abdominal pain well marked, chiefly in upper abdomen; also present in hypogastrium. Rigidity all over abdomen. Had vomited six or seven times since he was hit; small amounts with no hæmatemesis. Pulse rising slowly.

TIME BETWEEN WOUND AND ADMISSION.—25½ hours.

TREATMENT.—Abdomen opened in middle line. Liver wounds were small and left alone, as bleeding had ceased. Two holes in stomach were sutured. Lesser sac full of blood. Lower border of pancreas wounded. Nothing done. (*Vide* later drainage of lesser sac.) Fragment found lodged in fourth part of duodenum. (The 'syphon' above transverse mesocolon.) An exploring finger dislodged it and it passed on into jejunum. The wound in duodenum was stitched. A gastrojejunostomy was then done by the posterior route. Two drain tubes (1) suprapubic and (2) into lesser sac, and the abdomen closed.

RESULT.—Died.

REMARKS.—The patient lived four days, and then died. He developed a pancreatic fistula on the second day.

Post mortem. Gastrojejunostomy and wound in stomach had healed. Wound of duodenum apparently leaking, but very slightly. Cause of death probably septicæmia due to a gas-forming organism. The heart's blood was gaseous, as also was that in liver. There was retroperitoneal hæmorrhage in which were gas formations.

Case 17.—*January* 16, 1916.

VISCERA WOUNDED.—Iliac colon: completely divided, involving terminal branches of inferior mesenteric artery, spermatic vessels, and gluteal artery.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Left buttock, external to and below great trochanter. Small, but oozing blood. *Exit:* Through left rectus (semilunar line).

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient on admission was blanched and collapsed and practically pulseless. Signs of free blood in peritoneum. Left buttock much distended with blood.

TIME BETWEEN WOUND AND ADMISSION.—About 16 hours.

TREATMENT.—As patient did not react after two hours to morphia, salines, warmth, and rest, it was decided as a last resort to open the abdomen. The patient stopped breathing during the induction of anæsthesia. An incision was made into the abdomen and the heart massaged through the diaphragm. Breathing was re-established for a few minutes, but patient ultimately expired without anything further being done.

RESULT.—Died.

REMARKS.—*Post mortem.* The gluteal artery (superior trunk of) had been divided. The spermatic vessels were cut across. The iliac colon was completely divided, a large tear in the mesocolon involving branches of inferior mesenteric artery. No peritonitis.

Case 18.—*March* 14, 1916.

VISCERA WOUNDED.—Transverse colon: two wounds anterior and posterior; fragment lodged in wall of gut posteriorly. Cæcum: one hole in anterior surface; fragment in lumen.

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—*Entrance:* Right rectus, 1 inch above umbilicus. *Exit:* None (colon).

OTHER WOUNDS.—Right loin: mid-axillary line over 10th costal cartilage, large and ragged. Left semilunar line: just below costal margin; fragment just under skin. Right arm contained cloth and gas bubbles. Scalp: small wound. Right groin: small fragment. Compound fibula, right side; offensive; large and ragged, and gaseous. Left hip: through skin and fascia.

SIGNS AND SYMPTOMS.—Pale and collapsed, but rallied with rest, warmth, salines, etc. Had never vomited. Considerable abdominal pain. Abdomen rigid, especially above umbilicus. No distention. Pulse 88. Next morning had rallied sufficiently to allow of laparotomy.

TIME BETWEEN WOUND AND ADMISSION.—21 hours.

TREATMENT.—Wounds were explored and found to enter the abdomen. Right paramedian incision through rectus. Wounded colon resected and end-to-end anastomosis. Small wound of cæcum sutured. No other gut lesions. Catheter tied into cæcum. Suprapubic drain inserted. Abdomen closed. The other wounds were incised and cleaned thoroughly, fragments of shell and clothing being removed, and the wounds washed out and dressed, after the laparotomy. This prolonged the operation, and was in some measure, we believe, responsible for his death.

RESULT.—Died.

REMARKS.—Patient never rallied, and died ten hours later from shock.

Post mortem. Cæcal wound and colon junction quite air-tight and apparently all right. No other wounds had been overlooked.

Case 19.—*March* 13, 1916.

VISCERA WOUNDED.—Liver: fragment lodged in right lobe.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Right loin, mid-axillary line, midway between costal margin and crest of ilium. Skin wound double, although only one missi e.

SIGNS AND SYMPTOMS.—Patient's general condition good. Had never vomited. Belly tender and rigid, mainly over upper half of right rectus and right obliques.

TIME BETWEEN WOUND AND ADMISSION.—20½ hours.

TREATMENT.—Laparotomy. Incision through right rectus. Fragment felt in right lobe of liver, far back; with some difficulty this was removed. There was profuse bleeding for some minutes, controlled by firm pressure with a gauze swab. Drain tube inserted through loin track, and on into track in liver. Laparotomy wound closed completely.

RESULT.—Recovery.

REMARKS.—Bile issued from drainage tube for four days, and then serum only drained out. Laparotomy wound healed by first intention, and there was never any invasion of the general peritoneum. Discharged to base March 22. Heard from on March 30. Wound healing well. Tubes and stitches all out.

Case 20.—*March* 17, 1916.

VISCERA WOUNDED.—Jejunum: five perforations. Ileum: six perforations. Iliac colon: one perforation on the peritoneal aspect.

MISSILE.—Shrapnel bullet (quite whole).

WOUNDS OVER ABDOMEN.—*Entrance:* Tiny puncture directly above left great trochanter, perforating ilium 1 inch below crest. *Exit:* Ball lying in right rectus muscle, midway between umbilicus and pubis.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient had vomited once before admission. Was in considerable pain, and looked anxious. No distention. Rigidity most marked in left iliac region. Pulse 104 (88 on admission two hours previously).

TIME BETWEEN WOUND AND ADMISSION.—6 hours.

TREATMENT.—Laparotomy (11.30 p.m.) through left paramedian incision. Eleven perforations in all, found in small gut, and one in iliac colon. A good deal of blood in abdomen. Five perforations in jejunum were separately sutured. The six holes in ileum were included in a resection of 2½ feet of gut, with end-to-end anastomosis. Colon perforations closed with sutures. Iliac colon mobilized and drain tube passed through hole in pelvis to drain retroperitoneal tissues. Suprapubic drain. Bullet extracted. Abdomen closed in layers.

RESULT.—Recovery.

REMARKS.—Patient stood the operation well, which took two hours. He made an uneventful recovery, save for a little bronchitis. Discharged to base April 1. Sinuses into pelvic (suprapubic), and up to hole in iliac bone still discharging slightly. Heard from twice in England. April 12, "Going on well." May 15, wounds nearly healed. Gets up a few hours every day.

Case 21.—*March* 23, 1916.

(Wounded 2.0 a.m. Admitted 9.0 a.m. Operated upon 13 miles behind trenches at 11.0 a.m.)

VISCERA WOUNDED.—Kidney: left lower third pulped by bullet which had split organ open in its flat axis, laying open the lower calices and nearly encroaching on the hilum. An artery was bleeding freely in the kidney substance near the hilum. Transverse colon: two holes about its middle. Bullet had come forwards through kidney and then colon, and was found lying between layers of gastrocolic omentum, between stomach and colon.

MISSILE.—Bullet.

WOUNDS OVER ABDOMEN.—*Entrance:* Left loin, posterior axillary line, just below costal margin. *Exit:* None (*vide* under Viscera wounded).

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient very pale and collapsed on admission, and very restless. Considerable pain in left lumbar region. Also pain in right iliac fossa Tenderness and rigidity most marked in upper and left lumbar regions. Hypogastrium and right iliac regions, not tender. Had vomited once before admission.

TIME BETWEEN WOUND AND ADMISSION.—9 hours.

TREATMENT.—Laparotomy through right rectus. About one pint of blood in abdomen. No wounds in small gut. Two holes close together found in transverse colon. A small bleeding vessel in great omentum was ligatured. Holes in colon were sutured. Bullet extracted from great omentum. To left of duodenojejunal flexure and internal to descending colon, a small perforation was seen in posterior peritoneum. Through it dark blood was oozing rapidly. Finger pushed through felt the disorganized lower pole of kidney. Incision made on outer side of descending colon into a large retroperitoneal hæmatoma, which extended from splenic flexure to crest of ilium and duodenojejunal flexure to outside descending colon. The colon was pushed forwards and inwards upon the hæmatoma. The kidney was freed and delivered in the laparotomy incision. An attempt was made to seize and tie a large vessel spurting from the region of the hilum; but this failed, so a semicircle of mattress sutures was inserted in the kidney substance, compressing the two lips of the tear. This sufficed to control the bleeding. The kidney was dropped back. The incision through peritoneum on outer side of colon was sutured. A drain tube was pushed through entrance wound (after enlarging the wound) up to lower pole of kidney. Suprapubic drainage of pelvis. Abdomen closed in layers.

RESULT.—Recovery.

REMARKS.—About the time that the kidney was being delivered, the patient suddenly became very collapsed. Two pints of saline were given subcutaneously. To the saline, adrenalin ½ dr. and pituitrin 0·5 c.c. to the pint were added, on the advice of Captain R. Kennon, R.A.M.C. (T.C.). The patient improved wonderfully, and the operation was completed. There was severe shock afterwards, and the patient had lost a lot of blood. The legs were bandaged and an additional three pints of the saline mixture described above were given. Condition critical for first two days, developing a posterior tibial thrombosis. Some retching and occasional vomiting till fourth day, when an enema opened the bowels, and the retching ceased. Neither before nor after the operation did any hæmaturia occur, nor was there any discharge of urine, or urinous fluid from the loin drain tube; nor was there any collection of fluid in the lumbar region. The amount of urine passed in the twenty-four hours, March 28 to 29, was 40 ounces. Two attacks of typical renal colic, followed by an urgent desire to micturate, occurred on March 28. Wounds healing well. Discharged to base April 1. Heard from twice in England. April 13: Had some frequency and dysuria still. April 28, writes: "Wounds healed. The urine trouble is quite over, and I do not get the pains now; in fact I feel sometimes as though I shall get quite well, and after having sick leave, will be preparing to come to France again."

Case 22.—*March* 29, 1916.

(Wounded 9.0 a.m. Admitted 2.30 p.m. Operation 6.45 p.m.)

VISCERA WOUNDED.—Left kidney: ragged, freely bleeding wound of outer border, opposite lower end of hilum. Depth from border ¾ inch, length along border 1¼ inches. Calices not opened. Spleen: ragged wound of postero-external margin, entering renal surface, with exit by diaphragmatic surface. Large enough to pass finger through. Small 'bridge' of margin intact.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Size of shilling through left erector spinæ, just below costal margin. *Exit:* None. On seventh day after operation a small abscess pointed in left mid-axillary line over 10th rib; in it was found the missile, which measured about ½ inch by ¼ inch by ¼ inch.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Pale and collapsed, obviously bleeding internally. Temperature 98° and pulse 120, small and thready. Left half abdomen very tender and rigid. Right iliac fossa quite soft and not tender. Had vomited once since admission, not before. Hæmaturia copious, and black from abundant blood, which settled at bottom of test tube.

TIME BETWEEN WOUND AND ADMISSION.—9¾ hours.

TREATMENT.—Laparotomy through left rectus. Three-quarters of a pint of

blood in abdomen. Splenic wound still bleeding freely. Hæmostasis secured by deep mattress sutures of catgut. A large retroperitoneal hæmatoma round left kidney was incised on outside of descending colon, and kidney delivered in laparotomy wound. The renal wound was also bleeding, and again hæmostasis was obtained with catgut mattress sutures. Kidney replaced. Tube from perirenal tissues, out through loin. Tube into pelvis suprapubically. Abdomen closed.

RESULT.—Recovery.

REMARKS.—For three days after operation there was a diminishing amount of hæmaturia. Fourth day no macroscopic blood in urine. On seventh day the axillary 'missile' abscess was opened, and the fragment presented to the patient, transforming a hitherto despondent man into a happy, cheerful one. The amount of pus was under a drachm. On eighth day there was a rather large 'lumbar cushion,' and the urine showed a cloud of albumin on boiling. Lumbar cushion rapidly cleared up. Two attacks of epistaxis after operation, and some bleeding from raw edge of a skin pucker in the laparotomy incision, which elsewhere healed by primary union. Discharged to base April 9. Heard from April 25: "Everything healed very well." Medical officer in charge of case at Sheffield writes June 2: "Wound healed well. He rapidly gained strength. On no occasion was either blood or albumin found in urine. Sent to convalescent home. June 9, getting up."

Case 23.—*April* 4, 1916.

(Wounded April 3. Admitted April 4, noon. Operation 5.0 p.m.)

VISCERA WOUNDED.—Liver: missile deeply imbedded in liver far back towards Spigelian lobe. Too deeply placed to extract. (Abdominal musculature also wounded in another place.)

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—*Entrance:* Right side mid-axillary line, level of 10th rib, size of sixpence. *Exit:* None.

OTHER WOUNDS.—Left iliac fossa region; fragment had ploughed into abdominal muscles, and was lodged just outside anterior superior spine of ilium. Bubbling with gas.

SIGNS AND SYMPTOMS.—Patient looked very ill. Pain and tenderness all over abdomen. Pulse small and thready, and about 140.

TIME BETWEEN WOUND AND ADMISSION.—Time of wound not known. Interval probably about 20 to 24 hours.

TREATMENT.—Median laparotomy. Considerable amount of blood in pelvis and right paracolic fossa from wound in liver. An attempt was made to extract the missile, but failed. A gauze pack was passed through the chest wall wound (and incidentally through wounded pleura) and on into track into liver, and sutured to edge of entrance wound. Abdomen closed.

Fragment extracted from wound in left iliac region and track laid open. Very foul, and infected with a gas-forming organism.

RESULT.—Died.

REMARKS.—On second day after operation laparotomy wound had to be opened for infection from wound in left iliac region. Infection foul and offensive and 'gassy.' Patient also had a copious expectoration from a broncho-pneumonia of right lung. Died April 9. No post-mortem was done.

Case 24.—*April* 5, 1916.

(Wounded 7.0 p.m. Admitted April 6, noon. Operation April 7, 11.0 a.m.)

VISCERA WOUNDED.—Liver: portion of liver from right lobe (free margin) 1½ inch by ¾ inch, blown away and lodged in muscles of abdominal wall (exit wound). Kidney: graze of lower pole. Spinal cord: concussion changes as high as 11th dorsal segment. Bullet traversed 2nd and 3rd lumbar vertebræ.

MISSILE.—Bullet (rifle).

WOUNDS OVER ABDOMEN.—*Entrance:* Left loin through erector spinæ, leve

of 1st lumbar spine. *Exit:* Right loin in posterior axillary line, level 3rd and 4th lumbar spine.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient in great pain and completely paralyzed below umbilicus. Vomiting, collapsed and with rapid small pulse. Evidences of peritonitis. From exit wound, offensive discharge with bubbles of gas escaping.

TREATMENT.—Operation: Incision made through exit wound parallel with costal margin opening peritoneum. Detached portion of liver was removed. Liver bleeding had ceased. Hepatic flexure of colon not injured. Finger passed along bullet track (which emerged into peritoneum, through right psoas), felt the hole in 3rd lumbar vertebra. Tube into retroperitoneal tissues (psoas region), one into region of gall-bladder, and suprapubic 'stab' tube to pelvis.

TIME BETWEEN WOUND AND ADMISSION.—16 hours.

RESULTS.—Died.

REMARKS.—Patient required catheterization for retention, and was generally helpless. He became distended and showed signs of a spreading peritonitis. On the day before his death he had a profuse hæmaturia. He gradually sank, and died at midnight on April 11.

Post mortem. There was an extensive spreading peritonitis, from which he died. The bullet had entered the spine behind the transverse process of 2nd lumbar vertebra, completely traversing the spinal canal, and had emerged in front of the transverse process of the 3rd lumbar vertebra, and evidently produced concussion changes as high as the 11th dorsal segment. The liver was healing. The anterior surface of lower pole of right kidney showed a small linear graze.

Case 25.—*April* 16, 1916.

(Wounded 1.0 a.m. Admitted noon. Operation 2.0 p.m.)

VISCERA WOUNDED.—Ileum: four minute holes, 1 to 2 feet away from ileocæcal junction. There was a curiously acute and well-marked plastic peritonitis, of lower 3 feet of ileum and of cæcum.

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—Buttock: Right side. Three or four small holes, size of a threepenny-bit; foul and 'gassy.' Back: Over lumbar spine. Only one of the buttock wounds entered abdomen.

OTHER WOUNDS.—Multiple.

SIGNS AND SYMPTOMS.—Signs of abdominal injury wanting on admission. Towards evening he vomited and pulse began to rise. No dysuria. Some abdominal tenderness. Patient worse than buttock wounds alone warranted.

TIME BETWEEN WOUND AND ADMISSION.—25 hours.

TREATMENT.—Laparotomy through right rectus. Very little blood in abdomen. Resection of 6 inches of ileum, including three holes. End-to-end anastomosis. Suture of fourth hole. Peritoneum cleansed. Suprapubic drain—abdomen closed.

RESULT.—Died.

REMARKS.—He gradually sank, and died in afternoon of same day, twelve hours after operation.

Post mortem.—The junction was leaking, and there was an acute spreading peritonitis. No attempt at healing either of junction or of singly-sutured hole. There was gas in the buttock. Only one of the buttock wounds had penetrated the abdomen, and no gut lesion had been overlooked. The fragment entered the recto-vesical pouch, missing bladder and rectum. Junction was made in devitalized gut.

Case 26.—*April* 16, 1916.

(Wounded 1.0 p.m. Admitted 6.0 p.m. Operation 11.0 p.m.)

VISCERA WOUNDED.—Great omentum; mainly bruised; slightly lacerated.

MISSILE.—Multiple shell fragments; one only penetrating abdomen.

WOUNDS OVER ABDOMEN.—*Entrance:* Right semilunar line, midway between umbilicus and pubis. *Exit:* None.

OTHER WOUNDS.—Wounds of knee and hand. Ragged wound right quadriceps extensor region.

SIGNS AND SYMPTOMS.—Rigidity of right rectus, above and below the wound, and of right oblique muscles. He had vomited once soon after being hit. Good general condition.

TIME BETWEEN WOUND AND ADMISSION.—10 hours.

TREATMENT.—The edges of the wound in semilunar line, plus superficial fascia down to rectus excised *en masse*. Wound prolonged up and down for 2 inches each way. Rectus found to have been severed in its outer half. Fragment found just poking through peritoneum. Fragment removed. Edges of hole in peritoneum excised. Great omentum only bruised, some extravasation of blood. External wound cleansed of many small pieces of clothing, and closed round a drain.

RESULT.—Recovery.

REMARKS.—The wound in the parietes was very foul and contained innumerable small fragments of clothing. Part of the rectus was necrotic and was excised. The patient made an uneventful recovery, and was discharged to the base April 20. Heard from later in England as doing well.

Case 27.—*April* 30, 1916.

(Wounded 1.0 a.m. Admitted 10.0 a.m. Operation 11.0 a.m.)

VISCERA WOUNDED.—Liver: large lacerated wound right lobe, involving large veins. Kidney: right kidney extensively lacerated.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Epigastrium to right of mid line about one inch above transpyloric plane. *Exit:* Right loin, below costal margin.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient admitted practically pulseless from internal bleeding. It was decided as a forlorn hope to open the abdomen.

TIME BETWEEN WOUND AND ADMISSION.—10 hours.

TREATMENT.—Incision through right rectus. Large collection of free blood in peritoneum. Patient got rapidly worse on table before anything more than simple investigation could be done.

RESULT.—Died.

REMARKS.—Patient died on the table.

Post mortem.—Right kidney and right lobe of liver extensively lacerated. Patient died of hæmorrhage.

Case 28.—*April* 30, 1916.

(Wounded 12.30 a.m. Admitted 10.0 a.m. Operation 2.30 p.m.)

VISCERA WOUNDED.—Jejunum: two large ragged tears with everted mucous membrane 1½ feet from duodeno-jejunal flexure; also two smaller holes further down gut. Transverse colon: four small holes close together.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Left loin, through outer edge of erector spinæ. *Exit:* None. Fragment lying under skin over right rectus 1 inch below umbilicus.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Good general condition. Complained of abdominal pain in upper half. Vomited twice before admission. Rigidity most marked over upper half of left rectus.

TIME BETWEEN WOUND AND ADMISSION.—14 hours.

TREATMENT.—Incision through left rectus, removing fragment and cleansing site of arrest. Several ounces free blood in peritoneum. Resection of 1½ feet of jejunum with end-to-end anastomosis. The four holes in colon were sutured. Drain through entrance wound in loin, and one suprapubically.

RESULT.—Recovery.

REMARKS.—May 2.—Patient progressing well. Very fit. May 4.—Slight fæcal-

smelling discharge from loin tube. Question whether a wound of colon had been overlooked. May 10.—Heard from in England as progressing slowly though surely. May 26.—Had had another operation, leaving him better, but still very ill.

Case 29.—*April* 30, 1916.

(Wounded 1.0 a.m. Admitted 2.0 p.m. Operation 11.0 p.m.)

VISCERA WOUNDED.—Jejunum: four holes close together, about 2 feet from duodeno-jejunal flexure. The small shell fragment was imbedded in the wall of the gut in the fourth hole.

MISSILE.—Multiple shell fragments.

WOUNDS OVER ABDOMEN.—One penetrating wound of abdomen only. *Entrance:* Left loin, posterior axillary line below costal margin. *Exit:* None (*vide* Viscera).

OTHER WOUNDS.—Other small multiple wounds of back and buttock (left).

SIGNS AND SYMPTOMS.—Patient rather collapsed on admission, but rallied well. Definite pain, rigidity, and tenderness in left half of abdomen, best seen in upper half. Had not vomited.

TIME BETWEEN WOUND AND ADMISSION.—22 hours.

TREATMENT.—Laparotomy through left rectus. Very little blood and no intestinal contents extravasated in abdomen. The four holes in jejunum were included in one resection of 6 inches of gut. End-to-end anastomosis performed. Loin wound enlarged and drained. Laparotomy wound closed round a suprapubic tube. The other wounds were simply dressed at the operation, so as not to prolong the time on the table beyond the minimum required for the laparotomy.

RESULT.—Recovery.

REMARKS.—May 2.—Patient doing well. May 9.—Discharged to base, having done very well. May 11.—Heard from in England, when he writes: "I am pleased to say I am feeling in the pink; I am eating like a horse."

Case 30.—*April* 30, 1916.

(Wounded 11.0 p.m. Admitted May 1, noon. Operation 6.0 p.m. same day.)

VISCERA WOUNDED.—Left kidney: Large lacerated wound of lower half of kidney. In it some fragments of clothing were imbedded. Free hæmorrhage still going on.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Left lumbar region behind level of highest point of iliac crests, and half an inch from middle line. *Exit:* None.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Somewhat collapsed on admission, but rallied well. Vomited twice before admission and twice after admission before operation. Great pain and tenderness, especially marked over upper part of left rectus, which was firmly contracted. No hæmaturia.

TIME BETWEEN WOUND AND ADMISSION.—10 hours.

TREATMENT.—Laparotomy through left rectus. A primary incision of about 6 inches was made, and ultimately a very long incision was required. A few ounces of blood-stained fluid escaped. There was no lesion of any intraperitoneal viscera. A very large perirenal hæmatoma was seen on the left side, about the size of large fœtal head. No pulsation. Splenic flexure mobilized by incision on outer side and pulled down and in. Kidney freed and delivered in wound. An attempt was made to stop the bleeding with mattress sutures; but this failing, nephrectomy was performed. Kidney pouch drained through 'stab' in loin—suprapubic drain, and closure of abdomen in layers.

RESULT.—Recovery.

REMARKS.—Next morning patient had an attack of acute gastroplegia, treated by gastric lavage and eserine. May 5.—Patient doing well, save for considerable difficulty in opening bowels. May 9.—Progressing favourably. Copious brown discharge from loin tube. (Shell fragment not found at operation.) Discharged to base. May 10.—Heard from in France as doing well.

Case 31.—*April* 27, 1916.

(Wounded 6.0 p.m. Admitted April 28, noon. Operation 3.30 p.m. same day.)

VISCERA WOUNDED.—Bladder and rectum: missile had entered rectum on right posterior aspect, at upper edge of anal canal; it had left rectum through the prostate gland and so into bladder. Out of bladder by left upper angle.

MISSILE.—Shell fragment.

POSITION OF WOUNDS OVER ABDOMEN.—*Entrance:* Right buttock (ischiorectal fossa). *Exit:* Through left rectus 1 inch from middle line, and 1½ inches above pubis.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Pain and tenderness in hypogastrium. Urine escaping from exit wound. General condition good. He had been hit three hours since last passing urine.

TIME BETWEEN WOUND AND ADMISSION.—22½ hours.

TREATMENT.—Median suprapubic tube inserted down to, but not into, wound in bladder. Exit wound through rectus cleaned and drained. Peritoneum not wounded. A little blood and urine in rectum. Anal sphincter forcibly dilated. The holes in rectum easily felt and just admitted the tip of the forefinger.

RESULT.—Recovery.

REMARKS.—Apparently the bladder was fairly full when he was hit, and this may account for the peritoneal reflexion escaping injury. For three days after operation there was a good deal of hæmaturia. On fourth day none macroscopically. Enema given on fourth day, and a little was returned per urethram. Bowel therefore kept confined for a further three days, when they were opened without mishap. May 9.—Discharged to base, having done well.

Case 32.—*May* 16, 1916.

(Wounded 1.0 a.m. Admitted 11.0 a.m. Operation 3.15 p.m.)

VISCERA WOUNDED.—Cæcum: two wounds, each ¾ inch long, in anterior and posterior aspects respectively. A good deal of localized peritonitis and extravasation of cæcal contents.

MISSILE.—Shell fragment.

WOUNDS OVER ABDOMEN.—*Entrance:* Right loin, posterior axillary line immediately above crest of ilium. *Exit:* Right iliac fossa, 1½ inches above and internal to anterior superior spine of ilium.

OTHER WOUNDS.—None.

SIGNS AND SYMPTOMS.—Patient's general condition quite good. Complaining of great pain in right lower quadrant of abdomen, and also above pubes. Tender and rigid, mainly in right iliac fossa. Had vomited once or twice before admission.

TIME BETWEEN WOUND AND ADMISSION.—14¼ hours.

TREATMENT.—Right iliac fossa opened by muscle-splitting operation, the incision passing through the exit wound, which was completely excised *en route* down to and including the peritoneum. Cæcum pulled out and holes sutured. Drain tubes (1) through entrance wound behind into external paracæcal fossa, (2) through position of exit wound in front into right iliac fossa, (3) suprapubic 'stab' drain into pelvis. The remainder of incision closed with through-and-through silkworm-gut sutures.

RESULT.—Recovery.

REMARKS.—When the abdomen was opened a well-marked peritonitis was found with actual pus formation. As only 14½ hours had elapsed since he was hit, a previous acute appendicitis was suspected. The appendix, however, was normal, save that its peritoneal coat was involved in the same way as the surrounding peritoneum. The infective processes were well shut off from the general peritoneum by recent adhesions, save that the pelvis contained a considerable quantity of purulent fluid. The patient did very well. Discharged to base on May 28. Condition on leaving: copious discharge from suprapubic pelvic drain. Incision healed by first intention, save round tube into right iliac fossa. All three drainage sinuses granulating well.

REVIEWS AND NOTICES OF BOOKS.

Nerve Injuries and their Treatment. By PURVES STEWART, M.A., M.D., and ARTHUR EVANS, M.S., M.D., F.R.C.S. Demy 8vo. Pp. 220, with 97 illustrations. (Oxford Medical Publications.) 1916. London: Henry Frowde and Hodder & Stoughton. 8s. 6d. net.

THIS book is a lucid and elementary exposition of the main problems arising from the injuries of nerves. It contains nothing new; but to those unfamiliar with the writings of Head, Sherren, and Robert Jones, it should prove a useful *résumé* of their teaching.

Although the title suggests that all nerve injuries and their treatment are included, it is clear after reading the book that the injuries of nerves by projectiles in war was the theme that occupied the minds of the authors almost exclusively when they were writing it. Whilst this may enhance its immediate interest, its ultimate value may be thereby lessened. The treatment of traumatic neuritis, with its delayed onset, following upon a blow over the path of a nerve trunk in the course of civil occupation, is a common form of nerve injury that might have received more attention; whilst the account of such important lesions as obstetric palsies is very inadequate.

The description on p. 114 of the Erb-Duchenne type of upper arm palsy is poor and misleading, since no reference is made to the involvement of the external rotator muscles of the shoulder-joint—the spinati and teres minor—which are invariably involved in a lesion of the 5th cervical nerve: the resulting unchecked action of the internal rotators, chiefly the subscapularis muscle, is one of the most important factors, as Fairbank has shown, in producing a subsequent subluxation of the shoulder-joint. An appreciation of these facts is the key to the proper treatment of the injury, but the treatment of this palsy has not received any especial mention by the author.

Not all authorities would agree to the advice given on p. 64, under the heading of "New operative and expectant treatment," that "daily the limb should be removed from the splint and massaged." In the hands of a highly-skilled masseur this might be safe, but it is safer and equally adequate to massage the affected group of muscles without the removal of the splint until voluntary movement has returned to them. At the present time, when the number of nerve injuries is so great that all cases cannot be in the hands of highly-trained experts, the advice quoted above is fraught with considerable risk.

The detailed description of the origin and distribution of various nerves is spoiled in places by inaccuracies or omissions. Thus, in the diagram of the brachial plexus, p. 109, the posterior thoracic nerve is shown arising from four roots; on p. 125 the teres minor is omitted from the list of muscles supplied by the posterior cord of the brachial plexus; on p. 127 it is stated that in lesions of the outer cord of the brachial plexus "the intrinsic muscles of the hand are not involved," but in the description of the case shown to exemplify such a lesion, p. 128, it is stated that "all the intrinsic muscles of the hand were paralysed;" and on p. 161, the statement that "lesions of the musculospiral nerve in the lower third of the arm are not accompanied by anæsthesia," requires some amplification.

Whilst these are some of the more obvious defects of the book, it remains to be stated that the subject matter is clearly arranged and well illustrated. The broad outlines of the subject are rendered easily accessible to the beginner, and the work should prove of value to him, provided he is content not to probe too critically into details.